April 1947

TECHNOLOGY REVIEW

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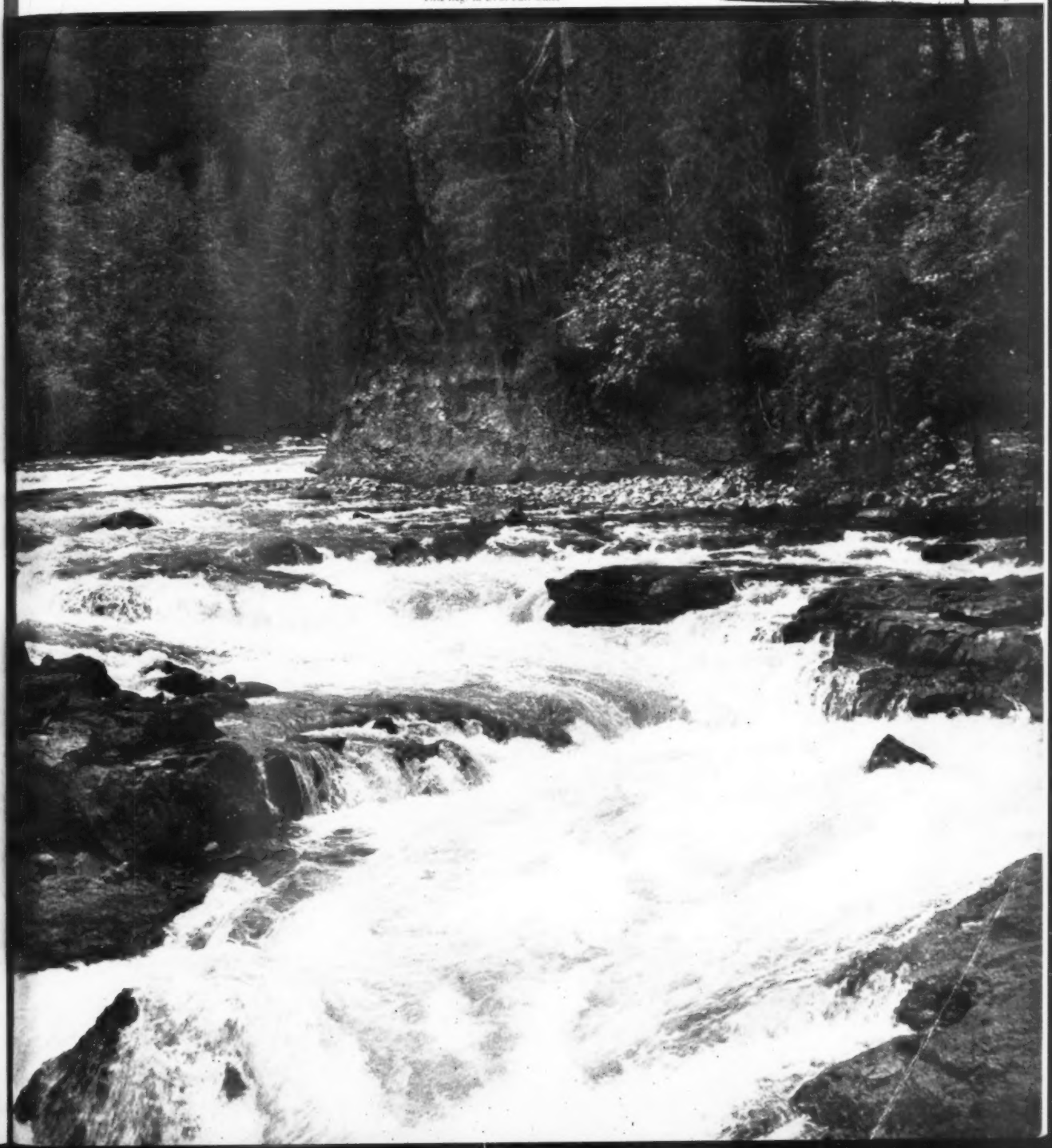

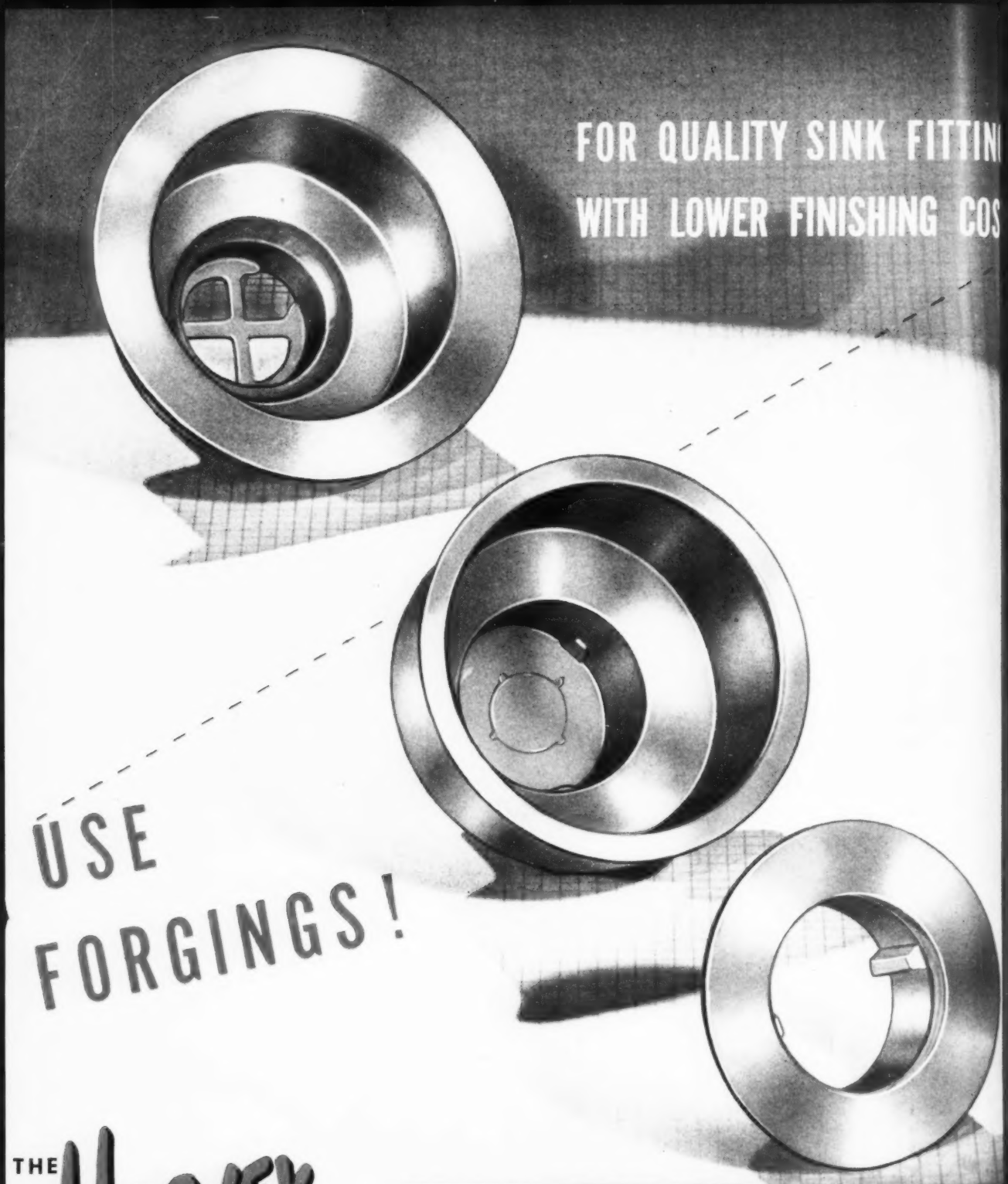

THE HARVEY METAL CORPORATION

HAROLD B. HARVEY '05 • *Engineers & Manufacturers* • SHERRY O'BRIEN '17

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FORGINGS IN ALUMINUM • BRASS • BRONZE • COPPER • MAGNESIUM • MONEL • ALLOY

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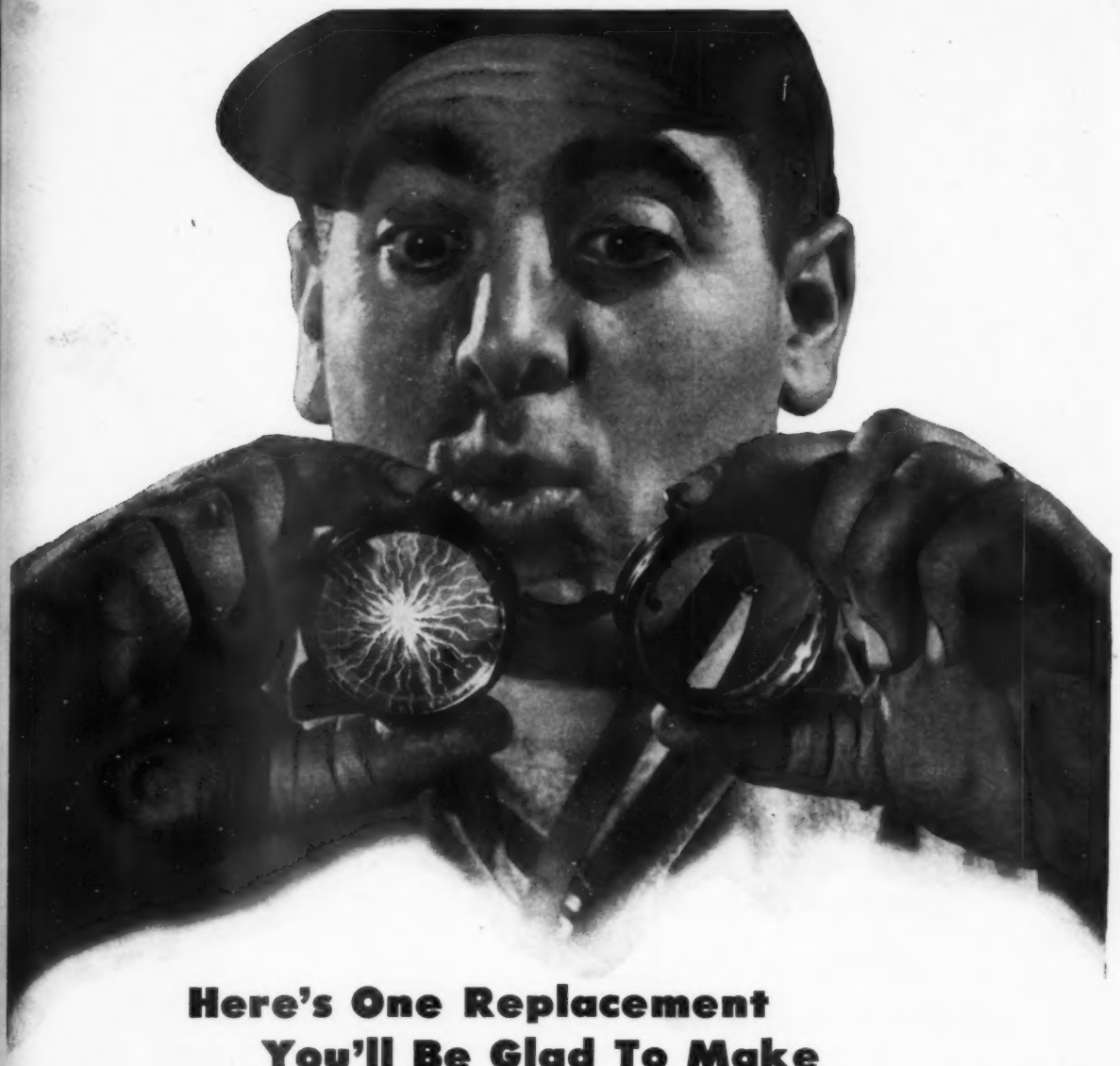

Here's One Replacement You'll Be Glad To Make

You'll find it much cheaper to replace a broken goggle lens than to pay compensation and other costs for a lost eye.

The average cost of a pair of goggles is only $1.50. New Lenses cost much less. The cost of even a minor eye accident is substantially greater — often totalling many hundreds of dollars.

Compared to safety goggles, there is hardly a piece of plant equipment that requires such a small outlay for original installation or which saves its cost in such a short time.

Send to your nearest American Optical Safety Representative or direct to the American Optical Company, Box T, for a copy of the new book "Eye Accident Costs," telling how much eye accidents cost, how to prevent them and how much you can save by preventing them.

American Optical COMPANY *Safety Division*

SOUTHBRIDGE, MASSACHUSETTS

BRANCHES IN PRINCIPAL CITIES

THE TECHNOLOGY REVIEW, April, 1947. Newsstand Edition. Vol. XLIX, No. 6. Published monthly from November to July inclusive at 10 Ferry Street, Concord, N. H. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription $3.50; Canadian and Foreign subscription $4.00 Entered as second-class matter at the Post Office at Concord, N. H., under the Act of March 3, 1879.

FOR INDUSTRY

Godfrey L. Cabot, Inc., and its subsidiary companies supply a broad sector of American industry with fundamental raw materials and some fabricated products. Behind these materials and products lies a background of thorough, painstaking research, geared to the most modern methods of production. By tradition and by training, all of the Cabot companies are research and production minded, and their output has to be *right* before it is offered for sale.

Carbon Black
Natural Gas
Natural Gasoline
Pumping Equipment
Pine Tar
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77 FRANKLIN STREET · BOSTON 10, MASS.

Here's What NORTON Makes . . .

How Many Are You Using?

Abrasive Products

Grinding wheels of ALUNDUM*, CRYSTOLON* and diamond abrasives; discs and segments; bricks, sticks and hones; mounted points; abrasives for polishing, lapping, tumbling and pressure blasting; pulpstones.

Grinding and Lapping Machines

A varied line of machines for production-precision grinding and lapping and for the tool room — including special machines for crankshafts, camshafts, rolls and car wheels.

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High temperature refractories— grain, cement, bricks, plates, tile, tubes — for metal melting, heat treating and enameling; for ceramic kilns; for boiler furnaces and gas generators; for chemical processes; refractory laboratory ware; catalyst carriers; porous plates and tubes.

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Trade-mark for Norton Boron Carbide — the hardest material made by man. Available as an abrasive for grinding and lapping; in molded products for extreme resistance to wear — especially effective for precision gage anvils and contact points; and for metallurgical use.

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ALUNDUM* Floor and Stair Tile, ALUNDUM* Ceramic Mosaic Tile and ALUNDUM* Aggregates to provide permanently non-slip (wet or dry) and extremely wear-resisting floor and stair surfaces.

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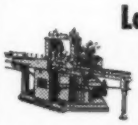

Single and duplex automatic labeling machines for applying labels and foil to beverage bottles and food, cosmetic and drug containers.

Oilstones and Coated Abrasives

Sharpening stones and abrasive papers and cloth for every use of industry and the home craftsman. Products of the Norton Behr-Manning Division, Troy, New York.

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NORTON

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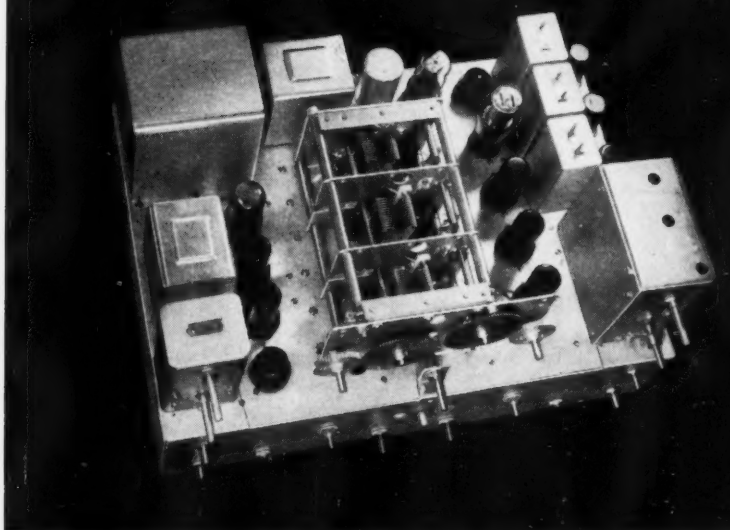
IN ANSWER TO HAMS' DEMANDS

EST. 1914

Hams around the world have been National's collaborators in creating the NC-173—ready now after five years of intensive research. Here are some of the advantages this 13-tube superheterodyne receiver offers:

- The NC-173's newly designed adjustable threshold double diode noise limiter—working on *both phone and CW*—has an extremely high limiting efficiency because of the short recovery time.
- Voltage regulated circuits give the NC-173 high stability and less drift for changes in powerline voltage. The pitch of code characters barely changes—even over extended listening periods.
- The S-meter circuit allows signal strength recordings to be taken on either *phone or code*.
- Works equally well on coaxial feedline, single-wire, directional or balanced antenna.
- AC powered. Will also operate on battery for portable or emergency use—110/120 or 220/240 volts, 50/60 cycle. Frequency range .54 to 31 and 48 to 56 MC. (Includes calibrated band spread on 5, 10, 11, 20, 40 and 80 meters).
- Ask your dealer to let you see and hear the new moderate-priced NC-173.



THE NATIONAL NC-173

NATIONAL

COMPANY, INCORPORATED

MALDEN, MASS.

THE MOST DISTINCTIVE NAME IN RADIO COMMUNICATIONS

Arnold presents:

another step towards a complete line of permanent magnet materials . . . . .

CAST ALNICO I

CAST ALNICO II

CAST ALNICO III

CAST ALNICO IV

CAST ALNICO V

CAST ALNICO VI

CAST ALNICO XII

SINTERED ALNICO

SINTERED ALNICO

In general SINTERED ALNICO MAGNETS do not compete with, but rather supplement, magnets produced by the cast method to widen the scope of potential permanent magnet applications.

Alnico magnets weighing roughly one ounce or less should be produced by the sintered method.

Heavier magnets of more intricate shapes can be produced. For some applications Sintered magnets are more economical because:

1. Magnetic characteristics are practically the same as Cast Alnico.
2. Sintered Alnico is a fine-grain, homogeneous material which has more uniform flux density, is easier to grind, and provides better surface finish.
3. Sintered Alnico magnets can be produced to closer dimensional tolerances:

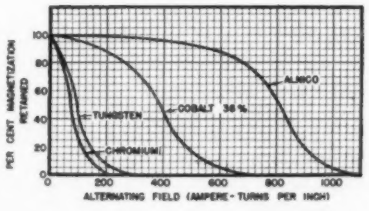
SINTERED ALNICO II	CAST ALNICO II
0.000 to 0.125 — + .005	0.000 to 2.00 — ± 1/64
0.126 to 0.625 — + .010	2.0 to 4.0 — ± 1/32
0.626 to 1.250 — + .015	4.0 to 6.0 — ± 3/64
1.251 to 3.000 — + .062	

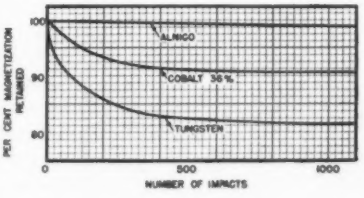
Grinding can in many applications be eliminated.

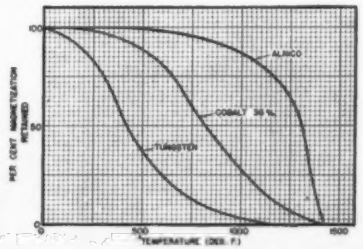
4. More intricate shapes, including holes, inserts, etc., are more feasible.
5. Transverse modulus of rupture is several times greater.

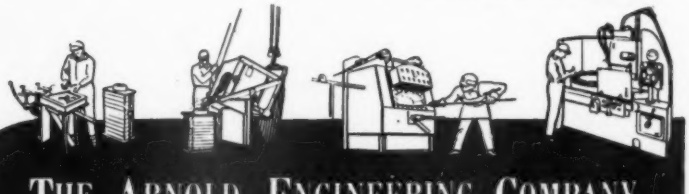
All Alnico, and particularly Sintered magnets, have very high values of Coercive Force (which is the capability of resisting demagnetization or loss of magnetism due to stray fields and from heat and vibration).

The curves show roughly the effect of these demagnetization factors on Alnico compared to other alloy steels.









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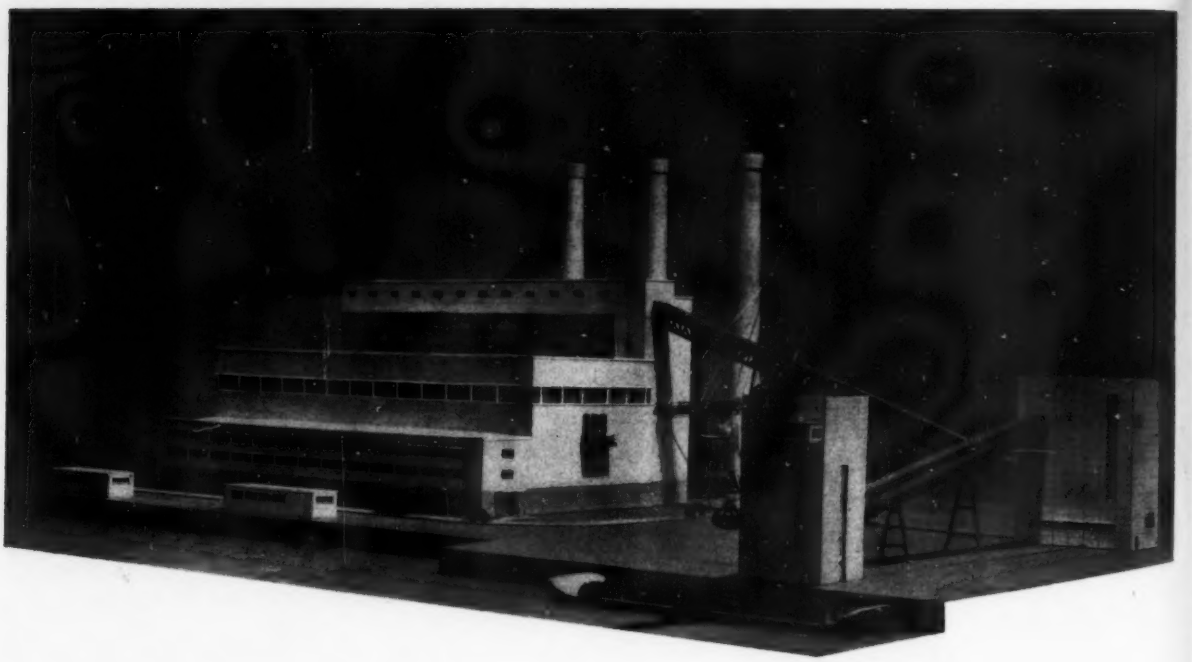
Specialists in the manufacture of PERMANENT MAGNET MATERIALS



Steam will be hotter — at Sewaren

These three factors are the unwritten plus-values in every C-E contract —

Knowledge — *to solve today's, and tomorrow's steam generating problems.*

Experience — *to interpret, from a world-wide background in every important industry, the specific needs of each installation.*

Facilities — *to manufacture complete steam generating units for every requirement, from 30 boiler horse power up to the largest.*

In a power plant, steam temperature has a direct effect on economy and efficiency. Higher temperatures mean lower fuel cost and greater efficiency. But progress has trodden on the heels of the metallurgists and designers. Twenty years ago 750° F was a daring experiment. Today, with new alloys and improved designs, steam temperatures have passed the 1000° mark.

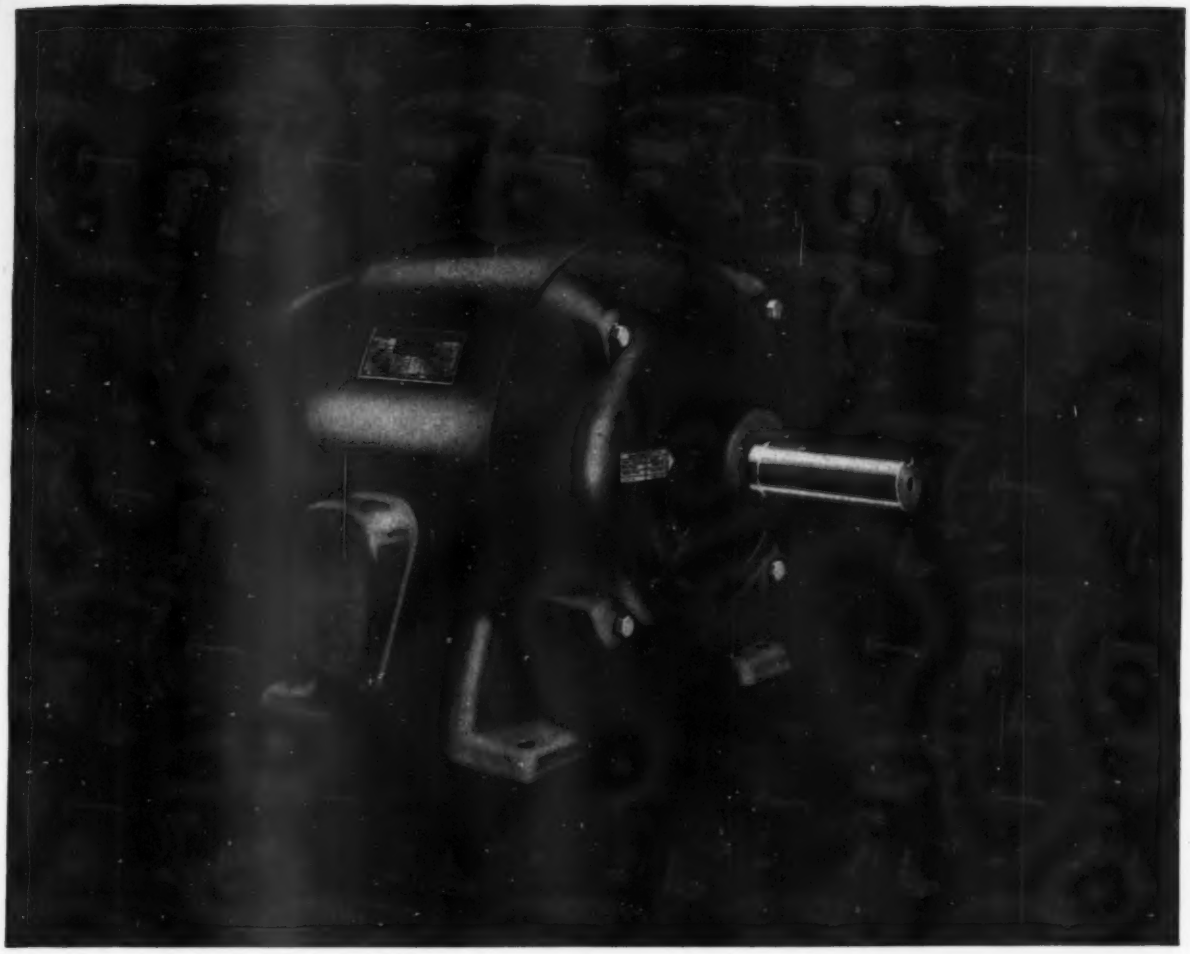
At Sewaren, New Jersey, the newest power station in the Public Service Electric & Gas Company system, steam will be generated . . . for the first time in power station practice . . . at 1050° F. The initial section of this station will house three huge C-E Steam Generating Units supplying steam at this temperature and at a pressure of 1500 pounds per square inch to three 100,000-kilowatt turbine generators.

The end, of course, is not in sight. Still higher steam temperatures will permit still greater economy and efficiency in power generation as soon as metallurgists can provide boiler and turbine designers with suitable materials. Combustion Engineering has played, and will continue to play, a leading part in this development. C-E was the first to design and build a boiler unit to operate at a steam temperature above 900° F. It is again first in the range above 1000° F.

And the same engineering vision that has aided so materially in the development of high temperature units is reflected in C-E steam generating equipment for all industry, from units of 30 boiler horse power up to the largest yet built. B-116

COMBUSTION ENGINEERING

200 MADISON AVENUE, NEW YORK 16, N. Y.



How to make one motor fit all user-ideas

For years, motor users complained that no one motor had *all* the features they wanted most.

Westinghouse engineers surveyed motor users to find out exactly what they needed . . . and then tailored an entirely new motor to fit those requirements.

The result is the new, outstanding Life-Line motor that has more benefits users asked for than any other motor made today. For example, it is the first motor that:

1. *Requires no lubrication for at least 5 years*
   This means more to the user than just the elimination of lubricating. It lets him use motors in his production line wherever they fit best, without regard to easy access for frequent servicing.

2. *Is much smaller than predecessor*
   What's more, it's lighter, more rigid and can withstand greater impact because of the all-steel frame. All of these benefits offer important advantages to every motor user.

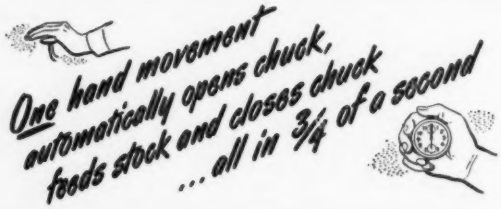
3. *Produces 134% more power per pound*
   Despite its lighter weight and smaller size, the new Life-Line motor gives users 134% more power per pound of weight.

The exclusive Life-Line motor is a prize example of the way Westinghouse studies the needs of industry and develops equipment to answer those requirements. It's part of Westinghouse planned research in every field of science to give industry—and you—better products.

J-80012

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE



ON BROWN & SHARPE WIRE FEED SCREW MACHINES

●These machines make it easy to save time on turning, drilling, threading and forming operations. On bar work, one motion of the hand on a trip lever engages the automatic power advance of the bar and coincident opening and closing of the collet. For second operations a single hand motion opens the chuck, the piece is inserted and then another hand motion closes the chuck.

Write for illustrated catalog on Nos. 0, 1, and 2 Brown & Sharpe Wire Feed Screw Machines. Brown & Sharpe Mfg. Company, Providence 1, R. I., U. S.A.

B·S

BROWN & SHARPE

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Hevi Duty Electric Co.

Surges Transformers

With the acquisition of the Surges Electric Company of Milwaukee, Hevi Duty can now offer quality dry type air cooled transformers with or without tap changing switches as well as special transformers for special requirements. An accelerated program of modernization will present opportunities for increased production and good delivery schedules.

Write for Bulletin S-4611

HAROLD E. KOCH '22, *President*

ELTON E. STAPLES '26, *District Manager, Cleveland*

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THE TABULAR VIEW

Tumbling Waters.— The cover for this issue of The Review is from a chlorobromide print originally exhibited at the Technology Galleries by SHIRLEY M. HALL of San Marino, Calif. Although it is not every month that we are privileged to reproduce the work of a fellow of the Royal Photographic Society, several of Mr. Hall's prints have appeared in The Review's pages during the past year, with benefit to this publication and, we hope, with advantage to the photographic artist. The Review takes this opportunity to express the hope that the work of many another may be reflected from the pages of its future issues.

For All to See.— Television continues to appeal with tremendous interest to the vast majority of people in this country, even though the decade-old promise of early widespread use of the new visual agency has not, even yet, materialized. But if it has thus far failed to make its entry into all but half a dozen of our largest cities, if it is still waiting to round that famous corner, television has nevertheless already made substantial contributions to technical progress in electronics, wire and radio communication, and radar, as is recorded (page 333) by DR. V. K. ZWORYKIN, associate director of the R.C.A. Laboratories.

Paving the Way.— Back of the successes of our armed forces lie months of planning, preparation, and engineering construction, all of which are urgently needed to pave the way for the culmination of modern tactical operations. Drawing upon the rich background of navy experience, built up since his graduation from the Institute in 1917, COMMODORE W. MACK ANGAS adds to the list of articles he has written for The Review to present his vivid account (page 337) of the splendid work of the Seabees of the Seventh Fleet, described as providing the "Stepping Stones to Victory."

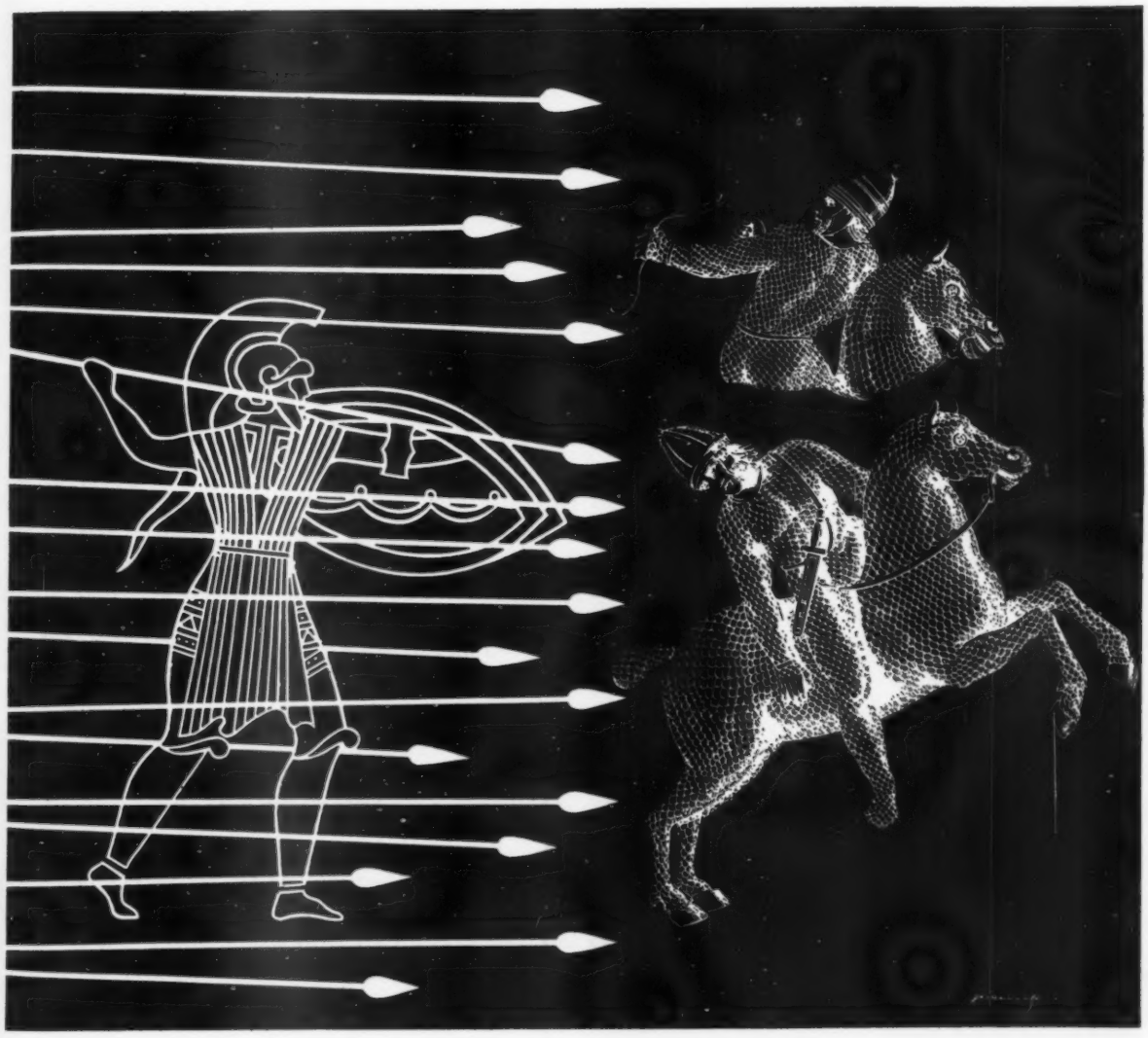
City Slickers.— Pursuing his favorite topic of social movements and the human aspects of modern industrialism, PAUL MEADOWS outlines (page 341) the difficulty which the city dweller finds in becoming a significant human being. Although viewing the problem with the detached point of view which might be expected from a professor of sociology at the Montana State University at Missoula, Dr. Meadows has had at least one chance to observe, firsthand, the effects of metropolitan industrialism in the Chicago area while studying for his doctorate at Northwestern University.

Error of Our Ways.— Although based on observations in the field of anthropology, in which he is recognized as scholar and skilled writer, the admonitions of M. F. ASHLEY MONTAGU (page 345) are equally valid, and applicable, in any field of human endeavor. The errors into which man has sometimes been led are particularly disturbing and significant to those in scientific pursuits. Dr. Montagu, a frequent contributor to The Review, is associate professor of anatomy at the Hahnemann Medical College and Hospital of Philadelphia.

THE MACEDONIAN SURPRISE PARTY

When the proud Persian hordes plunged headlong at Philip of Macedon's army, they were dumped into the minor leagues by an entirely new strategy, the phalanx: a solid wall of warriors sixteen ranks deep. Strength-in-depth withstood and defeated the impact of an over-confident enemy.

Molybdenum steels are economical means of getting the strength-in-depth called hardenability. With it, you're assured of dependable performance under severe service conditions. Practical facts are available to show you where molybdenum can go to work for you.



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CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

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World's Greatest Toolmakers

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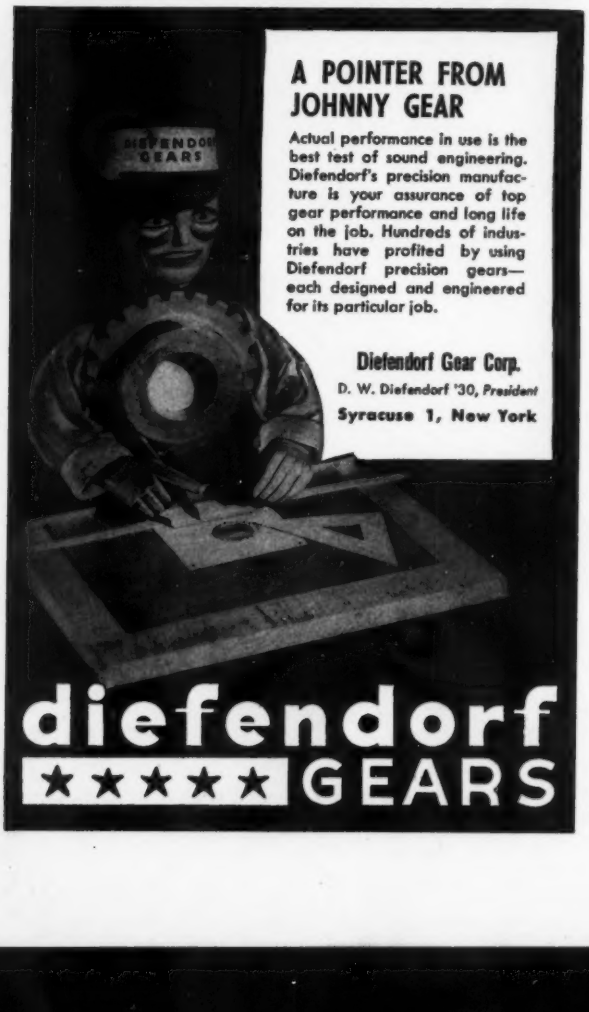
PRECISION TOOLS • DIAL INDICATORS • STEEL TAPES • GROUND FLAT STOCK
HACKSAWS • BAND SAWS FOR CUTTING METAL, WOOD, PLASTICS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Actual performance in use is the best test of sound engineering. Diefendorf's precision manufacture is your assurance of top gear performance and long life on the job. Hundreds of industries have profited by using Diefendorf precision gears—each designed and engineered for its particular job.
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MAIL RETURNS

Hobgoblins in the Library

FROM CHARLES H. BLAKE, '25:

In his article "The Wreck of Matter and the Crush of Worlds" in the November, 1946, issue, John Burchard has given an excellent summary of the real and increasing problems which face those who have to deal with the still-growing output of "literature." One can take no real exception to anything he says. Even so, I am moved to raise one doubt and to underline one problem.

The doubt pertains to the validity of extrapolations of the growth curve of literary output. We know that the growth rate of literary output has increased within historic times but it is contrary to all evidence on population growth to suppose that it will continue to increase geometrically for an indefinitely long time. In view of the attained or approaching population peak of the western nations, I raise the question whether, even with due allowance for continued population growth in the eastern nations, we are not fairly near the peak of literary growth rate. Please note the distinction between growth and growth rate; even if the rate is stationary, the annual increment may still be appalling. Let the librarians give some thought to making real and meaningful extrapolations rather than raising hobgoblins.

The essence of the whole matter is to render accessible what exists. It is suggested, as often before, that the solution is a business machine system. Burchard recognizes, and it cannot be too often emphasized, that the crux of the problem is not the machine but the brain governing the machine. I venture to suggest that only a small fraction of productive workers have both the temperament and the type of mind that would make it possible for them to give even a fraction of their time to being the brain behind a machine.

The problem of punching a card is more complex than it appears at first sight. Even the question of how facts are classified has no simple or routine solution. I remember vividly the distress of one of the men from the Center of Analysis at M.I.T. who consulted me in quest of a "formula" for classification, and was told that the biological taxonomist had no such formula and considered each case on its own merits.

It is hardly necessary to stress the foremost biological difficulty, the very number of entities, their shifting ranks and positions, and changes of view as to synonymy. We need only mention that there are said to be over 160,000 generic names of animals in current use and untold thousands of synonyms for them. I have just taken down Tuthill's account of North American jumping plant lice and find 25 synonyms against the first 10 generic names. Most of these synonyms are more or less frequent in the literature as valid names, either for jumping plant lice or for other insects. The problem of tying these synonyms together by cross references becomes worse than the straight indexing.

(*Concluded on page 354*)

Speed with Economy

We have recently completed
our 17th contract for
R. H. MACY & CO., INC.

whom we have had the pleasure
of serving since 1921

W. J. BARNEY CORPORATION
101 PARK AVENUE, NEW YORK
INDUSTRIAL CONSTRUCTION
Alfred T. Glassett '20, Vice President

Ignorance is the curse of God, knowledge the wing wherewith we fly to heaven."—SHAKESPEARE

Why some things get better all the time

HOOP SKIRTS AND PRINCE ALBERTS are only fond memories now. Far smarter the styles of today . . . and equally striking are the constant *improvements* in the *quality* of clothing.

There now are beautiful synthetic fabrics, in stunning variety—all made possible by chemistry. And woolens, cottons and other fabrics are processed and dyed more effectively—thanks to special new chemicals, and equipment of stainless steel. There are eye-catching hat decorations, smartly styled footwear, buttons, belts and suspenders of colorful long-life plastics. And rainwear of vinyl plastics provides new comfort and protection in stormy weather.

Clothing for just about any occasion is today more attractive and more serviceable than ever before . . . because it is made of things that are *basically better.*

Producing better basic materials for the use of science and industry and the benefit of mankind is the work of UNION CARBIDE.

Basic knowledge and persistent research are required, particularly in the fields of science and engineering. Working with extremes of heat and cold—frequently as high as 6000° or as low as 300° below zero, Fahrenheit—and with vacuums and great pressures, Units of UCC now separate or combine nearly one-half of the many elements of the earth.

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NEW LUBE OIL PLANTS...

...to produce maximum yields of high grade lube stocks at minimum cost.

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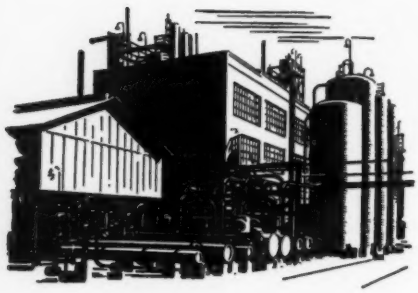

If you are contemplating a modern lube oil plant for the economical production of premium lubricating oils, put your problems up to Lummus. With laboratories and pilot plants equipped with every facility for lube oil evaluations, including vacuum distillation, propane deasphalting, solvent refining, solvent dewaxing and clay finishing, Lummus is in position to evaluate any crude and give, in addition, complete development, design and construction service.

For leading oil companies, Lummus is now building nine lube oil plants—thirty-one units in all—including vacuum distillation, propane deasphalting, solvent refining, solvent dewaxing, and clay finishing. These plants will have a total capacity of about 27,000 barrels of finished oil per day. Incidentally, these projects include 8 of the 22 solvent refining plants and 11 of the 30 solvent dewaxing plants designed and built by Lummus.

Lummus engineers are available for a thorough study of individual problems. They are ready to project processes through laboratory and semi-commercial operation, and equipped to determine construction and operating costs for a thorough consideration of the economics of each proposal.

Are you interested in modern, low-cost lubricating oil plants?

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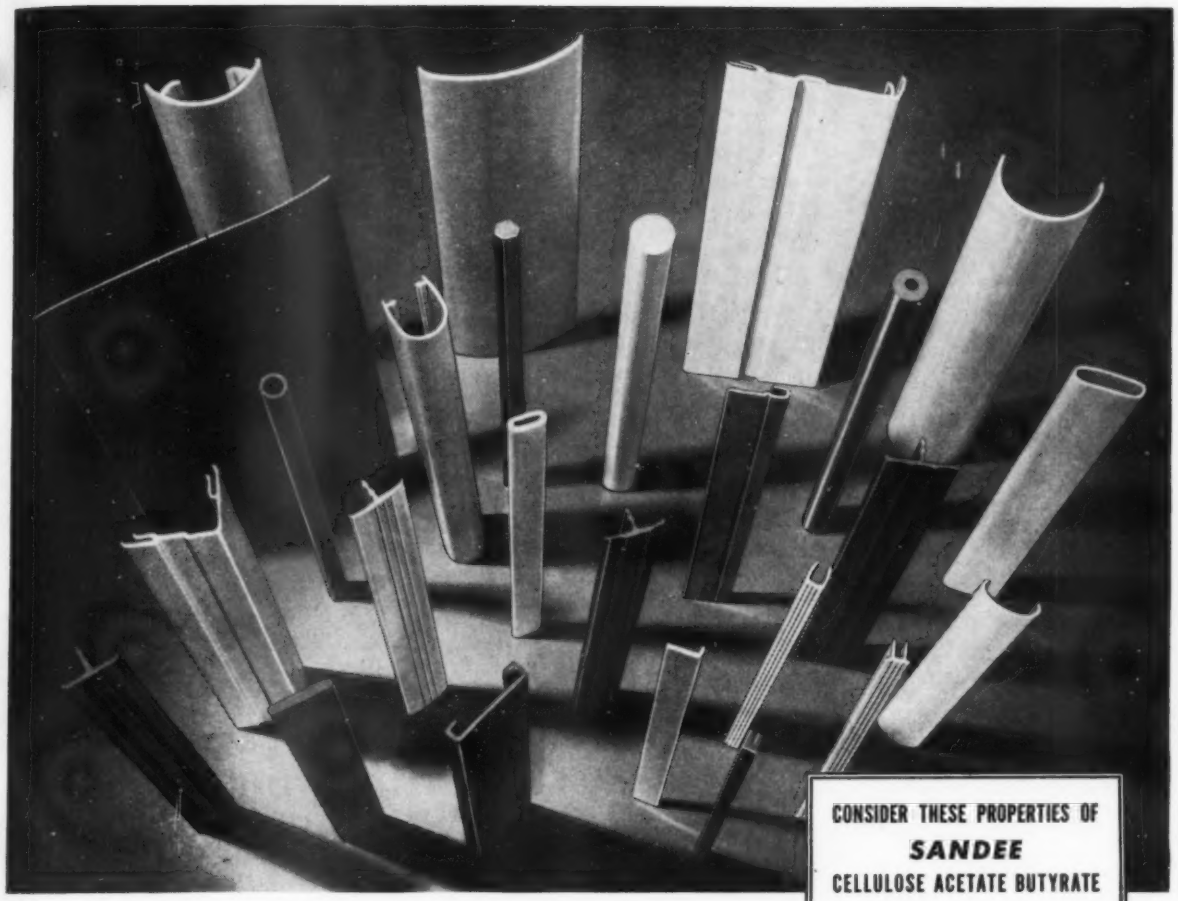

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The Early Bird

VOLUME 49 NUMBER 6

THE TECHNOLOGY REVIEW

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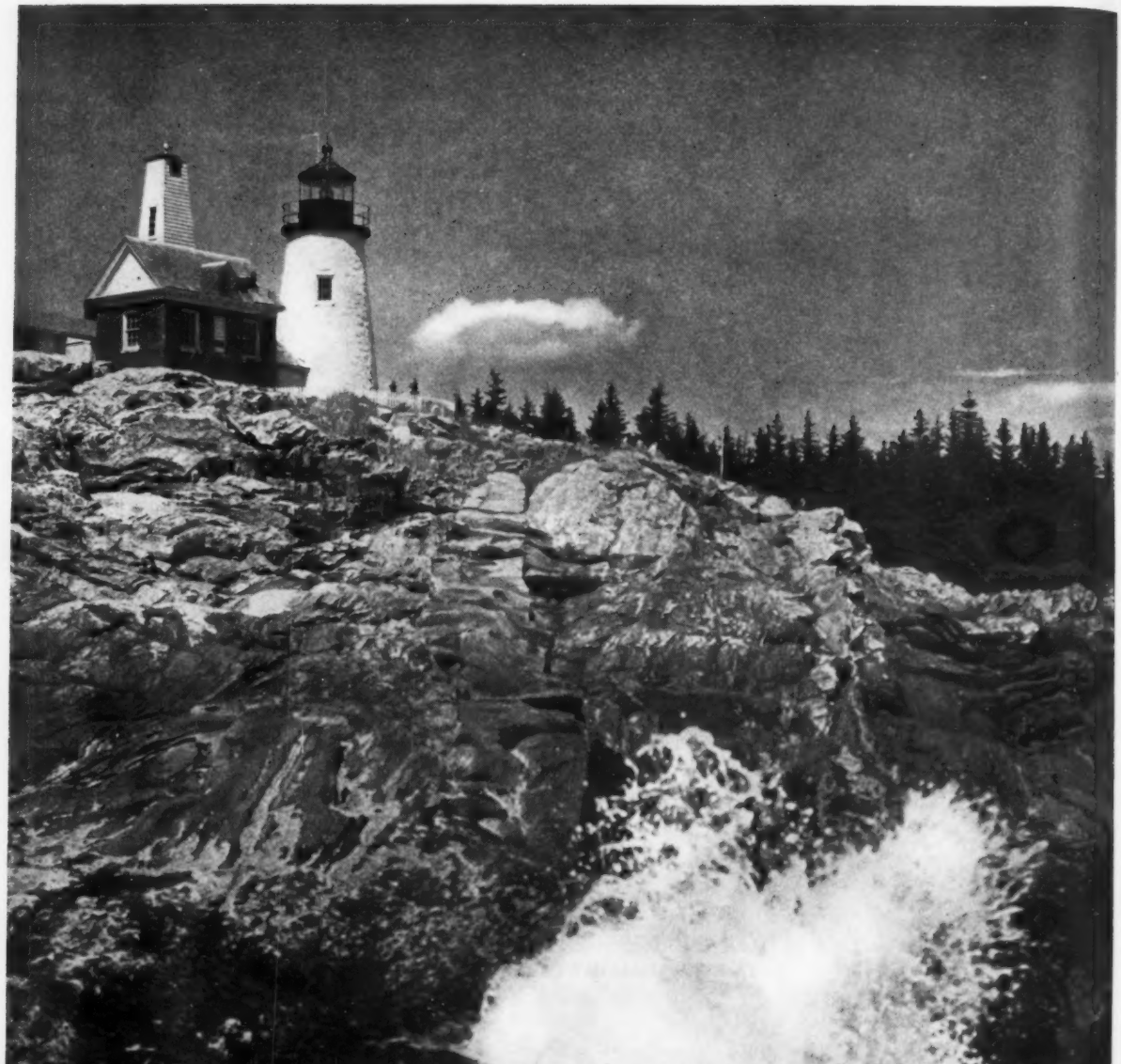


David W. Corson from A. Devaney, Ind.

Pemaquid Point Lighthouse

THE
TECHNOLOGY
REVIEW

Vol. 49, No. 6 April, 1947

The Trend of Affairs

From Astronomy to Television

DURING the 1930's the late Bernhard Schmidt, optician at the Bergedorf Observatory, near Hamburg, Germany, invented a unique camera, and incidentally, one of the most important of recent additions to the astronomers' arsenal of tools. Knowing that a spherical mirror has but the one error of spherical aberration, although to a degree that renders it useless for most optical purposes, Schmidt placed in front of it a correcting plate, a thin, weak lens that cancelled out that aberration while adding virtually none of its own. The fact that the correcting plate had an aspherical surface, one that could not be ground on any machine then extant, was doubtless of small moment to him, for the hand figuring of lenses was his daily work. But, for a time, the practical difficulty of lens grinding quite effectively restrained commercial applications of this system, in spite of its great light-gathering power and razor-sharp definition. Schmidt optical systems have been built to the very large aperture ratio of f/0.6. If the correcting plate is ground in the same piece of glass as the mirror (a solution known as the solid Schmidt, and limited in general to small cameras) further improvements are possible and the almost incredible speed of f/0.3 is attainable.

It is reported that Schmidt's first use of his new camera was to read the epitaphs on the gravestones of a nearby cemetery. He later took a picture of a landscape about two kilometers away, using only starlight for illumination but this was not so much of a feat as it sounds, since the exposure time was two hours. However, the manifold virtues of his camera, one of which is its wide field of view as compared with a parabolic reflector of equal aperture (about 25 degrees rather than one degree for an f/1 system), soon led to widespread use of Schmidt cameras in astronomy, particularly as mapping instruments. Among the larger units is one with a correcting plate 26 inches in diameter at the Observatorio Astrotisico Nacional in Mexico, for which the largest prism on record was recently manufactured. A 48-inch Schmidt is at Palomar, and a 60-inch instrument is planned for one of Harvard's observatories.

The unmodified Schmidt does not project its image onto a flat field, as does the usual camera lens, but onto a spherical surface. Normally, this is a nuisance that taxes even the patience of an astronomer, but to the television research workers it is a simplification. The surface of the cathode ray tube, on which the television image is produced, is normally curved and can easily be made spherical. Furthermore, the television image is produced at considerable cost in equipment and cannot readily be made as large or as bright as is desirable. To make this image large enough to be seen comfortably by sizable groups, particularly by theater audiences, some form of projection apparatus is required. A projection system that makes the utmost use of the light coming from the face of the cathode ray tube is, of course, highly desirable. Compared to a conventional f/2 lens, a Schmidt projecting system can put about six or seven times as much light on the viewing screen. Large systems of the Schmidt type, with lenses of observatory proportions, have been built for theater work, but at heavy cost for the optical components. Methods of molding the correcting lenses of plastic have been developed, however, and the system has been proposed for creating larger images in home television receivers. Experimental models of projection television receivers using such an optical system were built and described before World War II.

While the uses of the Schmidt camera will undoubtedly become more numerous if the production difficulties surrounding the aspherical correcting plate are overcome, applications already include television pick-up cameras where, with the latest television tubes and infrared telescopes used during the war for night observations, they can follow a football game right into the dusk. One of these latter devices has an aperture of f/0.9 and a wide field of view.

The emergence of the Schmidt camera caused as-

tronomers to examine other possible systems of like properties, and some interesting variations have arisen. By and large, they tend to be more complicated than the Schmidt; all require a correcting plate, some involve two mirrors, and at least one requires that one or both of the mirrors depart from a true spherical surface. In turn, the newer optical systems permit a flat image field or a shorter tube length than the Schmidt, and are, in general, quite free of optical errors.

Spokesman for Physicists

RECENT changes which have been made in the constitution of the American Institute of Physics bring together in one organization the country's professional physicists in industrial and educational institutions. Formed in 1931 for the advancement of physics and the dissemination of information about physics, the American Institute of Physics has operated largely as a federation of its five founder societies, the American Physical Society, the Optical Society of America, the Acoustical Society of America, the Society of Rheology, and the American Association of Physics Teachers. The American Institute of Physics has also served the founder societies in the publication of their scientific journals and has itself published the *Journal of Applied Physics* and the *Review of Scientific Instruments*.

No change has been made in the organization, functions, and activities of the member societies who serve the specialized branches of nuclear physics, optics, acoustics, flow of materials, and education in the field of physics. Under the new plan, members of the five founder societies retain their membership in these societies but also automatically become members of the American Institute of Physics which is thereby able to act as spokesman for the nation's professional physicists and physics educators. Such unification comes at a particularly appropriate time because of the widespread public recognition of the part which physicists have played, and continue to play, in the advancement of today's living.

For those interested generally in the broad field of physics but who may not have the specialized interests to warrant membership in any of the more specialized societies, associate membership in the American Institute of Physics, with nominal dues, has been made available. It is believed that such membership will have a special appeal to many engineers, chemists, biologists, students, and others susceptible to an interest in physics.

Plans are in progress for the publication, by the American Institute of Physics, of a journal whose principal function will be reportorial rather than archival in character. The projected journal, which is to carry general news articles about physics and related sciences, will be made available to all members of the American Institute of Physics.

One-Minute Photography

CUSTOMARILY playing the quiet role of a sober, learned society devoted to a specialized branch of physics, the Optical Society of America made headlines on February 22 when Edwin H. Land, President of the Polaroid Corporation, presented a technical paper on a one-step photographic process at the Society's winter meeting in New York. He also demonstrated the possibility of obtaining finished photographic prints, completely processed and essentially dry, a minute after the shutter had been snapped. If the Eastman Kodak Company in 1890 originated the slogan, "You push the button, we do the rest," the Polaroid Company in 1947 could provide the sequel, "You push the button and out comes the picture."

Practical importance of the system of photography devised by Mr. Land is that it accomplishes in a single step all the processing operations of ordinary monochrome photography in an elapsed time of 60 seconds, or less, with a process which is essentially dry. Photographs can be seen and enjoyed at once, and, if the result is not what was expected, a new exposure can be made on the spot. Technical pictures can be put to immediate use without the delay inherent to normal photographic processes by the more conventional wet-processing methods. Portrait and advertising photographers may detain models in their studios and may even ask them to hold their poses until the desired effect is obtained. In the field

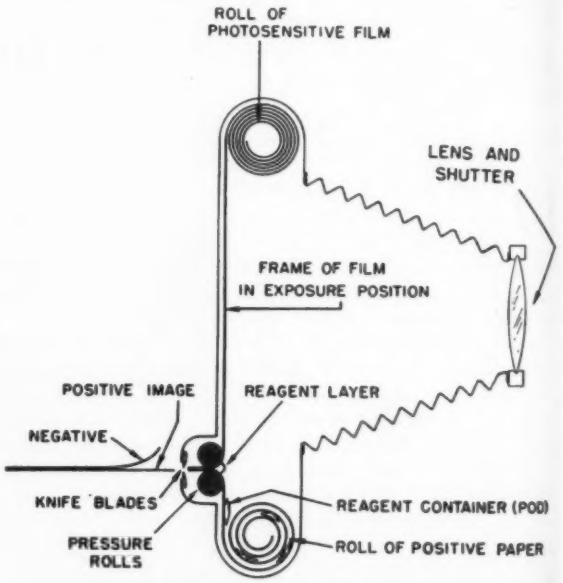


Diagram of camera for use in the one-minute photographic process indicates that production models, when available, may be similar to the ordinary folding camera except for the roll of chemically treated positive paper to which pods of processing reagent are affixed, and the pressure rolls and knife-edges through which the negative and positive image sheets are passed after exposure.

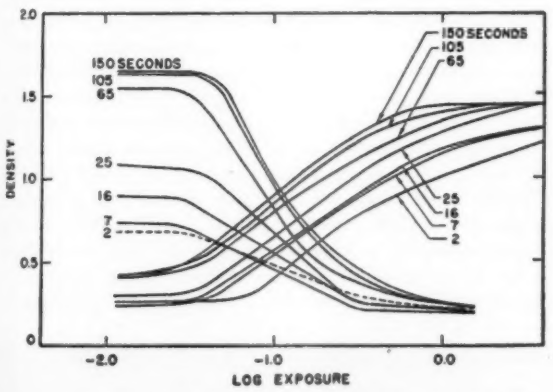
of amateur snapshots, no longer need Aunt Minnie appear in picnic scenes with her head neatly sliced off; the decapitated lady can be made whole on the succeeding exposure. The process should be ideally suited for use in those cases for which ample time is available for making camera adjustments but for which the opportunity to record certain scenes may come but once. Accordingly, the process may be expected to find considerable application in recording travel scenes.

Cameras for the new process can be manufactured in the same variety of sizes and shapes as conventional cameras for technical and amateur uses. They will contain no processing tanks or trays and need be appreciably no larger than present cameras for a given size of negative. But, for the present at least, the new photographic

process must be regarded as an interesting and important scientific disclosure of things to come. The next step, that of manufacturing the cameras on a large scale and of making the required photographic materials generally available, lies in the future.

Two premises were at the basis of all research carried out in the development of the new photographic process. It was stipulated that the cameras for the new one-step process were to be appreciably no different from those now used in making photographs, except that they were to be able to deliver finished prints dry, fixed, and ready for use. The photographic images were also to be produced by means of fast emulsions, using silver halide rather than other promising but very much less sensitive means of obtaining a positive print. Both of these objectives aim to achieve the utmost simplicity of operation on the part of the user. If, as has been said by Professor Arthur C. Hardy, '18, progress is measured by the extent to which operations are made simpler for the user at the expense of increasing the complexity of manufacturing operations, then the one-step photographic process certainly marks an important step in the progress of photography.

In brief, the process employs two types of photographic material which may, for convenience, be in the form of rolls. One of these is a sheet of photosensitive negative



Characteristic curves of the two classes of materials employed in the new photographic process. For the negative, the curves are approximately parallel, running diagonally from lower left to upper right. For the positive prints, the highlights (corresponding to the point at which the curves converge at the lower right) are not appreciably affected by processing time. The shadows become only slightly darker as processing time is extended beyond one minute, indicating that the time required for processing is not critical.

material which is loaded in the camera and exposed in the customary manner. The other is a sheet of chemically treated paper (for producing the positive print) inserted in place of the take-up spool for holding the exposed film in the ordinary roll film camera. A processing reagent, having about the viscosity of vaseline, is associated with either of these photosensitive materials, preferably the chemically treated positive material. After exposure in the usual manner, the negative and positive photographic materials, together with a measured amount of the processing reagent, are passed through a pair of pressure rollers. The reagent is spread uniformly between the two materials to form a temporary sandwich and simultaneously develops the negative and positive images. After about a minute of such processing, the two sheets are pulled apart to obtain a dry, positive print which is permanently fixed and requires no washing.

A technical description of several possible methods of obtaining the desired end result is given in the February, 1947, issue of the *Journal of the Optical Society of America*. Of the several possible methods of making finished photographic prints directly and promptly from the latent image in the negative, attention is directed to that process which appears most promising and which, therefore, has been most thoroughly studied.

As shown on page 330, the special camera has the usual lens, bellows, and film cartridge for the negative roll film which is inserted and exposed in the customary manner. An additional sheet or roll film for making the positive print may be inserted in the cartridge space usually reserved for the exposed film. The ends of both the photosensitive negative and the chemically treated positive materials are passed through a pair of pressure rollers. In loading, presumably one or both rolls will be aligned with a numbered index as is customary in the usual roll film cameras. Exposure is made in the usual manner, although the exposure is more critical than that required for ordinary monochrome negatives. After exposure, the negative and positive sheets are pulled through the rollers and cut or torn away from the camera. The sheets removed from the camera have their outer surfaces protected from actinic radiation to protect the negative from being fogged.

A reagent, in the form of the exact amount of viscous fluid needed to expose the negative and print, is fed between the two sheets just before they enter the pressure rolls. When negative and positive printing paper pass through the rolls, the pressure applied spreads the reagent as an extremely thin layer between the two sheets, temporarily binding them together as a sandwich. The thin layer of viscous reagent develops the exposed grains of the negative, and transfers the unexposed grains to the positive paper where a print is formed on its inner surface. After a processing time of about one minute, the two sheets are peeled apart, and are essentially dry. One of the sheets is the finished positive print.

For convenience in operation, the reagent is contained in small pods fastened at intervals to the sheets of either roll so that they are automatically carried into place as the two sheets feed through the rolls. As indicated in the illustration, the pods are attached to the roll of positive print material. The reagent pods are as wide as the photosensitive material but are only a fraction of its length. The pod is a water and oxygen opaque sheet, folded, sealed at the ends, filled with reagent, and bonded along the long edge. The edge-bond is so made that when the pod passes through the rolls, the hydraulic pressure of the liquid within bursts this edge and the small quantity of liquid is thus transported ahead of the rolls and between the two sheets. The quantity of reagent is such that there is negligible excess over that required for processing a single pair of images.

If the reagent were to have the viscosity of ordinary developing solutions, complicated devices would be required to spread it uniformly. As the reagent is made more viscous, the problem of spreading it becomes much simpler. After a small amount of water in the reagent has been imbibed in the adjacent layers, there is left on one of them a very thin film of material used to render the reagent viscous. In some of the processes which were

studied in the research program, the positive image is formed within this thin layer.

For the entire processing operation to be completed within a minute, it is economical of time to have the negative and the print processed simultaneously. Such a procedure has the further advantage of assisting in obtaining the high resolving power required for producing sharp prints.

The process is characterized by the simultaneous development of positive and negative images in adjacent layers, the positive image being formed from the silver halide of the unexposed grains of the negative. The reagent dissolves the unexposed grains while it simultaneously develops the exposed grains and precipitates the solution of unexposed grains as a metallic silver positive in a layer adjacent to the negative. The positive image is thus formed from silver halide grains originally in the negative, and which, in customary photographic processes, are dissolved away and wasted in the fixing bath of sodium thiosulphite.

The quality of prints obtainable by the new process is comparable to that obtained from the usual monochrome photographic processes. Exposure is about as critical as it is for color film and the contact prints are, of course, limited to the size of the negative. But against these minor limitations is the very important advantage of being able to see the finished print while there is still time to make a new exposure. Certainly many new and interesting photographic possibilities are opened up when it becomes possible to have prints without delay.

Newspaper photographers, for example, can leave finished prints on their editors' desks upon their return from a photographic assignment. Travelers can process their pictures en route. The process holds much promise for aerial reconnaissance, especially in case of emergencies where time may be an important factor. Radiographs can be made rapidly so as to speed up clinical diagnosis or industrial tests and production. No mention has thus far appeared in print regarding the extension of the one-step process to motion-picture photography, high-speed photography, photomicrography, or picture transmission, but all these fields, and many more, are likely to benefit from 60-second photography.

Miscellany Briefs

RADAR is among the most modern methods now being used in the search for possible oil reserves beneath the blue waters of the northwestern Bahamas. It is reported that radar targets 50 feet high are set up at strategic points in the areas of exploration. These structures enable the navigator of the equipment boat to pick up the targets on the screen of radar equipment and also permit geophysicists to plot oil sites with precision.

Among the new products that can be and are being made from petroleum and natural gas, Robert T. Russell, '22, recently listed synthetic soaps of superior quality, a type of resin that can be made into thin sheets and wrapped around highly perishable food products to keep them fresh during storage, cheaper but highly effective fungicides and insecticides, and a synthetic gasoline from natural gas that already appears to be economically competitive with gasoline made from crude oil.

A plastic tape for soldering wires and small metal objects without the aid of a soldering iron or torch is a product of modern research. The tape is made of flexible plastic, on one side of which is a layer of ordinary solder. The tape is wrapped about the object to be soldered and is then ignited. The burning plastic provides sufficient heat to melt the solder and yield the desired metallic bond.

It is estimated that probably not before 1948 will the shortage of textbooks which plagues the schools throughout the country be relieved. Something like 100,000,000 textbooks are in use in the elementary and secondary schools from coast to coast, but the normal demand is reputed to be about two and one-half times this figure.

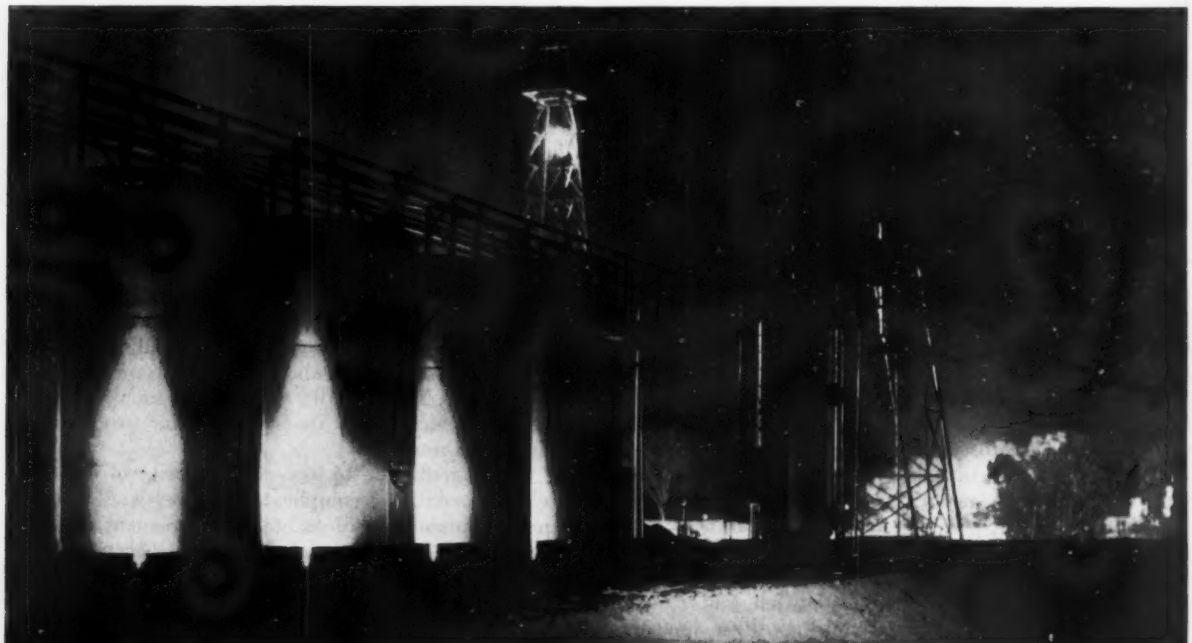


Photo by H. Armstrong Roberts

Television—Retrospect and Prospect

Many Useful By-products Have Resulted from Television Engineering. The Contributions which Television Can Make to Human Welfare Still Remain To Be Evaluated.

By Vladimir K. Zworykin

SCIENCE and engineering are closely interlocked; yet the basic motivations of the scientist and the engineer differ. The primary aim of the scientist is to understand; that of the engineer, to create. Having brought the engineering development of television to a stage where it may play a major role in human affairs, it is natural for those responsible to ask themselves whether the expenditure of time, thought, effort, and material goods has been justified by the new creation. It is this question which I shall try to bear in mind as I trace, briefly, the salient points in the development of television and consider its prospective uses. Essentially, the benefits conferred by the television program fall into two groups: the useful by-products of television research, and the contributions of television itself to human welfare.

The beginnings of television — the electrical transmission of visual scenes — may be traced back to the city of Boston. Here, in 1875, shortly after Willoughby Smith's [1] discovery of the light sensitivity of selenium, G. R. Carey [2] conceived of setting up a grid of selenium cells and connecting them individually to a similarly arranged set of electric light sources, whose light output they would control. Thus, in principle, if a picture of the scene was projected by a lens on the bank of photoelectric cells, a distant observer might see the image crudely reproduced on the bank of light bulbs. Carey did not succeed in actually transmitting a picture since the cell currents were too weak to activate either the lamps themselves or suitable relays. However, his system lives on today in animated advertising cartoons and news strips. A feature which it has in common with all subsequent television systems is the division of the scene or image into individual picture elements, (namely, the photocells and lamps of Carey's system, or their equivalent counterpart in modern television systems) whose total number determines the detail with which the picture can be reproduced.* On the assumption that the spacing of the picture elements in the horizontal direction is equal to that in the vertical direction, it is customary to describe the fineness of detail in a television picture, at the present time, by specifying the number of parallel lines of picture elements. This concept of picture lines achieved physical reality when it was suggested by Maurice LeBlanc [3] that the signals from the several picture elements should be transmitted in sequence to the receiver over a single channel, rather than simultaneously over a number of channels equal to the number of picture elements. Paul Nipkow [4] realized such a system by projecting an image of the scene on a so-called scanning disk in front of a single photoelectric cell. The rotating scanning disk was provided with a series of offset apertures in such fashion that successive apertures swept out successive scanning lines on the image and photocell. The observer looked at a second disk synchronized with the first and placed in front of a light source whose brightness was controlled by the output of the photoelectric cell. If the disks spin fast enough and the photocell current is strong enough to modulate the light source adequately, then, owing to the persistence of vision, the subjective sensation produced is the same as though the observer views a continuous picture of the original scene.

An Idea Converted to Reality

These, as well as later schemes, remained essentially inoperative as long as the electrical output of photoelectric cells was too weak to modulate the light sources in the receivers. It was only after the invention of the audion, by Lee deForest in 1907, that the amplification of small currents became a possibility so that the various schemes for the transmission and reception of pictures could be tested out in practice. More than that, vacuum tubes soon made possible the employment of radio waves as a television channel, so that the basic requirements for the presentation of television programs to a large, widely distributed audience were given. The subsequent development was rapid. Ingenious scanning mechanisms, employing high-speed rotating machinery, took their place both in the transmitter and the receiver. They were pushed to the limit in speed and dimensions in an effort to create pictures of sufficient detail to hold the interest of the viewer for prolonged periods. Much valuable experience was gained, but television systems using mechanical methods of scanning could not well provide sufficient detail to yield pictures that would compare with amateur home movies. What was required was a practically inertia-free means of selecting successive picture elements in the transmitter and of displacing a corresponding variable light spot over the viewing screen of the receiver. Beams of electrons, the lightest and most readily controlled particles in existence, filled the need. Since such beams can be deflected by varying electric or magnetic fields at frequencies exceeding the requirements of any television system, mechanical moving parts became altogether superfluous in a completely electronic system.

[1] Richard W. Hubbell, *4,000 Years of Television*, pp. 57, 62. (New York: G. P. Putnam's Sons.) Also, T. Thorne Baker, *Wireless Pictures and Television*, p. 21. (London: Constable and Company.)

[2] Hubbell, *op. cit.*, pp. 59–62; Baker, *op. cit.*, pp. 21, 169.

[3] Richard W. Hubbell, *op. cit.*, p. 63.

* Such picture elements are analogous to the dots in a halftone reproduction.

[4] Richard W. Hubbell, *op. cit.*, p. 65 ff.

1880 PROSPECT

Looking ahead to possible developments in the year 1952, an artist of 1880 visualized projection television applied to university education for women. Although the television apparatus of 1952 will differ considerably from the assembly of mechanical parts shown here, the artist has managed to predict quite accurately the technical possibilities which could be brought into play almost three-quarters of a century after this lithograph was made.

The Bettman Archive

The electronic tube forming the image in the receiver, called a kinescope, is a modification of the cathode-ray tube, originally used as an oscilloscope to provide visual indications of electrical phenomena. At one end of the cathode-ray tube is an electron gun which forms a fine, sharply focussed beam of electrons. The electrons in this stream are projected through the tube and produce a small spot of light where they strike a fluorescent screen at the other end of the tube. The beam is deflected over the fluorescent screen (which is usually several inches in diameter) by a magnetic field in such a way that the spot traces out a sequence of closely spaced, narrow, luminous lines on the fluorescent screen. That is, the spot travels over the fluorescent screen in a left-to-right, up-to-down scanning process similar to that which the eye makes when reading a page of print. The scanning process is repeated rapidly so that (in the absence of a television signal from the transmitter) the screen is uniformly illuminated.

In order to form a visual image on the screen of the kinescope the luminous region produced by the moving spot must be properly altered. At any instant of time, the brightness of the scanning lines is determined by the intensity of the electron beam, which in turn is controlled by a signal from the transmitter. To go one step further, the transmitted signal varies in accordance with the image being televised, in another scanning process at the transmitting station with which the receiver scanning is kept in step. The overall effect is that, at any instant of time, the brightness of any part of the image recreated at the receiver is proportional to the brightness of the corresponding part of the original scene. Since the entire screen is scanned 30 times each second, the image appears continuous to the eye.

It may be noted that the cathode-ray tubes existing at the time of origin of the kinescope were far from fulfilling the demands of television. The research which went into the development of electron guns to produce fluorescent spots of sufficiently small size and to provide adequate intensity made material contribution to the evolution of the science of electron optics which, since then, has culminated in the electron microscope.

The first electronic tube devised to serve as a true camera tube, i.e., to produce an electrical signal in accordance with the picture to be transmitted, was the iconoscope. In this tube, an optical image of the scene to be transmitted is projected onto a fine mosaic of photosensitized silver globules deposited on a mica plate with platinum backing. Each sensitized globule acts as an exceedingly small but very sensitive photoelectric cell, which accumulates an electric charge according to the amount of light reaching it. In a scanning process similar to that previously described, a beam of electrons sweeps over the mosaic, and liberates the electric charge stored by the individual globules. After the electron beam has removed the charge from any globule, this sensitive spot is removed from the scanning part of the system, but accumulates another charge in accordance with the amount of light striking it. This charge builds up until the globule is again discharged by the scanning beam, and hence each element stores up light-actuated, electrical energy between those intervals at which it is visited by the electron beam. It is to be noted that the iconoscope is superior to the mechanical pickup not only in the absence of moving mechanical parts, but also in being enormously more sensitive because of the storage of energy between scanning of individual globules of the mosaic. A tube employing the storage principle, like the iconoscope, may be several hundred thousand times more sensitive than equivalent tubes which do not use the storage principle.

1947 RETROSPECT

Looking back to earlier television accomplishments, this preview of a 1939 automobile, televised at Rockefeller Center on November 10, 1938, gives a clear indication of the technical quality of television images and an insight to experimental programs of almost a decade ago. The image shown here was photographed from the screen of the kinescope or viewing tube which yielded black and white pictures usually about five by seven inches in size.

Acme Newspictures, Inc.

The iconoscope was greatly superior to any earlier pickup device and still plays a leading role in television transmission. Nevertheless, it had certain defects which further research undertook to remove. One of these defects consists in a relatively low efficiency of the storage process: The other takes the form of shading, that is, dark patches were present in the picture and these had to be eliminated by the insertion of special shading signals which in turn reduced the sensitivity considerably below that expected for an ideal storage system.

Both of these drawbacks were overcome in the orthiconoscope, or the orthicon, for short. This highly sensitive pickup tube reproduces light variations faithfully over a wide range of intensities, but may become temporarily unstable if exposed to extraordinarily brilliant light.

Long before the realization of the orthicon, other efforts to increase the sensitivity and electrical output of the television camera tube had been undertaken and bore fruit in a new camera or pickup tube known as the image tube iconoscope. The electronic principle used in the image tube, developed in an effort to improve the signal output of television pickup tubes, has subsequently found a number of useful applications in other fields. During World War II the image tube became the means of observing enemy action by infrared radiation without betraying the observer. The effectiveness of the "snooperscope" and "sniperscope" is well documented.

Another effort to achieve an enhancement of picture signals took the form of the secondary emission electron multiplier. In it a small electron current (of primary electrons) incident on a target electrode yields a much larger current (of secondary electrons). Each primary electron can release or eject as many as 20 secondary electrons, much as a cue ball scatters many billiard balls on the break. This process may be repeated until the original current is multiplied by a factor of several millions, without introducing appreciable additional fluctuations in the current. Thus the electron multiplier serves to raise the signal level at the output of the pickup tube to such a degree that the noise introduced by the subsequent conventional amplifier becomes relatively negligible.

Again, the electron multiplier has found many uses far removed from the television field. If the first target electrode is replaced by a photoelectrically sensitive surface, the result is a phototube whose sensitivity enormously exceeds that of any earlier type of phototube. As such it has been applied for the measurement of star size, utilizing the diffraction pattern which moves across the earth as the star is eclipsed by the moon; for the determination of x-ray intensities, responding to the light emitted by a fluorescent screen facing the multiplier cathode; for the translation of weak light signals into sounds for the guidance of the blind; and to numerous other scientific and industrial purposes. In wartime, its enormous amplification and excellent dynamic response have been employed for creating uniformly distributed interference with the enemy's radio communications.

Improvements in Receivers

The advantages of the multiplier and the image tube have recently been combined with the orthicon principle in the image orthicon. This tube is stable at all light levels, exceeds photographic film in sensitivity by a considerable factor, and makes possible the transmission of recognizable scenes even when the illumination is nothing but bright moonlight. The limitations that remain are of a fundamental physical character, but also, although to a lesser extent, imposed by the great complexity of its construction.

The improvements in the pickup tubes have been paralleled by improvements in the receiver. Better designs of the electron guns and deflection systems for kinescopes have led to smaller and more intense electron spots, corresponding to increased demands on picture brightness and detail; new synthetic phosphors — the chemicals deposited on the screen of the kinescope and which produce fluorescence by impinging electrons — have yielded brighter images of a more pleasing shade or color; and optical systems of extraordinary light-gathering power, employed in conjunction with kinescopes operated at very high voltages, have made it possible for large projected television pictures to approach the brightness demanded in first-class motion picture theatres. The technique of coating the phosphor layer with a thin electron-transparent, light-reflecting film of metal, contributed to the enhancement of both the contrast and the brightness of the image. Finally, special methods of casting the aspheric plastic lenses required for projection type receivers have put this development economically within reach of the home.

It goes without saying that pioneer work in many other fields, such as wide-band circuit technique, antenna design, and wave propagation at ultrahigh radio frequencies, had to keep pace with pickup tube and receiver development. In addition to this, problems of program presentation and spot pickup began to be investigated at an early stage, so that, at the present time, a television service is available which provides black and white pictures of quality comparable to home movies within a radius up to 40 or 50 miles of the transmitting station. Such stations exist or are under construction in most of the major cities of the United States. A few are even now connected into networks by coaxial cables and ultrahigh frequency relay links. In heavily populated regions, such as the New York area, there are a considerable number of stations, partly in operation, partly projected, from which a variety of concurrent programs may be selected. About as many programs originate in the field, transmitting historic occasion, sports events, and the like, as in the studio, where stage presentations, motion pictures, periodic news, and educational features are provided.

Color Television

It has already been noted that the pictures which the television system provides are black and white or, at any rate, monochrome. This is unquestionably a limitation. Color aids both our recognition and our appreciation of a visual scene. Hence it is not surprising that, at a relatively early date, efforts were made to transmit and receive pictures in natural colors. At the present time, these efforts have led to two systems. The first employs sets of mechanically rotating red, green, and blue filters in front of the pickup tube and the viewing tube, respectively. Thus a sequence of red, green, and blue partial pictures is presented in rapid succession to the eye, which, owing to the persistence of vision, fuses them into a single natural color picture. This system is known as a sequential color system. In the second system the three red, green, and blue partial pictures are transmitted over three separate channels. The three separate pictures formed in the receiver are then superimposed by a stationary optical system, so that a single natural color picture is presented to the eye. This system is a simultaneous color system.

The sequential and simultaneous systems have two properties in common: They require a wider frequency channel for their transmission than black and white, and, at the present time, neither has been developed to the point where it meets the standards set for monochrome television.

Is Television Worth While?

We have seen that television research has accomplished two things: It has made possible a technically satisfactory television service and, in addition, it has contributed to numerous other valuable scientific and technical developments. One final question that requires an answer is this: Is a technically perfect television service likely to be worth while? The answer follows most readily from a consideration of the impact which television may have on our lives when its services become widely available and the primary problems which we face today.

Possibly the crucial problem of the day is the realization of a world in which the peoples will co-operate for their common welfare. The focus of the efforts in this direction is the United Nations. At the first meetings of the United Nations in New York, television played a two-fold role: Receivers were set up in the lobbies to make it possible for those who were unable to find a place in the main hall to watch the proceedings; in addition, several of the meetings were rebroadcast from New York to owners of television receivers distributed over a wide area. Both served to increase the contacts between delegates and the public. With the wider dissemination of television receivers such broadcasts should become a potent force in creating understanding for the peoples represented in the United Nations and counteracting the influence of prejudiced and inaccurate reporting.

Again, with the opening of the new Congress, television cameras were on hand in Washington to transmit the sessions to the nation. In our present democracy the lines of communication between the common citizen and his representatives have become long and tenuous. Special interest groups can readily exert a disproportionate amount of pressure on the member of Congress who remains out of touch with the bulk of his constituency. By showing the national legislation at work television may help to redress this situation, making democracy effective on a larger scale than heretofore.

There can be no question that the television broadcasts just considered must be regarded as educational. In addition, however, there is a wide scope for programs that are educational in a more restricted sense. The experience of the armed forces during World War II has amply demonstrated the extraordinary effectiveness of visual methods. Imagine a skilled musician showing the fingering of his instrument, an artist letting his work grow under his hands as he explains the principles of design, a commentator indicating the happenings of the moment on a descriptive map, the scientist demonstrating physical principles and chemical reactions by laboratory experiments, a skilled surgeon performing a delicate operation, the mathematician deriving his deductions with his customary symbols on the indispensable blackboard — all right in front of your eyes! Would this not be a ready way to increase your knowledge, broaden your interests, and thus enrich your life?

Yet it must not be assumed that the sole function of television is to instruct. (*Concluded on page 354*)

Stepping Stones to Victory

Herculean Efforts in Engineering Construction Support Successes Won by Modern Fighting Forces

By W. Mack Angas

Official Photograph, United States Navy

An important Seabee activity was the construction of piers and wharves, such as this pier on Los Negros in the Admiralty group.

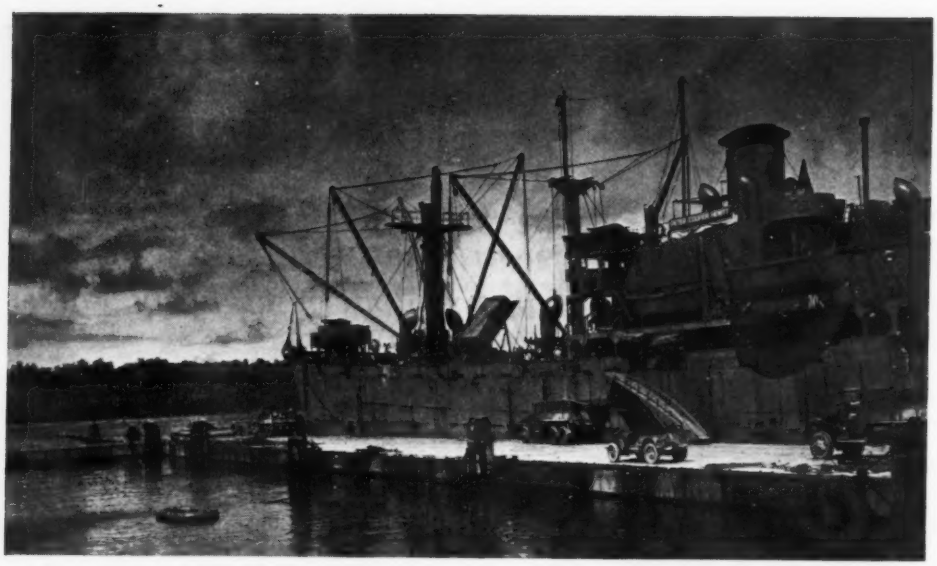
WHEN the Seventh Fleet, with its Seabees, became a unit of the Allied Forces operating under General Douglas MacArthur, as supreme commander in the Southwest Pacific area, the fortunes of the democracies "east of Suez" were at a low ebb. Pessimists believed the invasion, and possibly the seizure, of both India and Australia to be inevitable. Better informed observers were saying that the Japanese could be halted and held to the gains they had already made until victory over Germany permitted the transfer of men and equipment to the Pacific in such strength that the offensive could be taken with assurance. Those who insisted that the offensive could be taken effectively, with the forces that could be made available to the Pacific commanders prior to the defeat of Germany, were considered optimists.

But the optimists proved to be right! For, when Germany surrendered, Allied Forces had won control of the Pacific and adjacent seas, except waters contiguous to the islands comprising Japan, these islands themselves, and isolated enemy strongholds in which impotent garrisons were starving. To be specific, Allied Forces had driven the Japanese from the Aleutians; had control of the New Hebrides, Solomons, Bismarck, and Admiralty Islands and New Guinea; had occupied Saipan and recaptured Guam; had all but completed the reconquest of the Philippines; and over and above all this, had seized Iwo Jima and landed on Okinawa — the very doorsteps of the Japanese homeland. Therefore, when Germany surrendered, the Allied Forces in the Pacific were not merely preparing to take the offensive; they were getting ready to strike the knockout blow which brought about the unconditional surrender of Japan three months after V-E Day! An important contribution to the success of this great campaign was made by the Seabees, the efficient and effective Construction Battalions of the United States Navy.

The primary job of the Seabees in the Pacific was the construction and maintenance of the advance naval bases without which the Pacific fleets could not have operated effectively, if they could have operated at all, in areas as far from permanent Allied bases as those in which victory over Japan was won. The construction of these advance bases was one of the outstanding achievements of the engineering profession during World War II. A brief review of the methods used by the Construction Battalions of the Seventh Fleet in building advance bases in the Southwest Pacific is justified by the fact that the subject may now be discussed without danger of violating military security and because the participation of the Seventh Fleet Seabees in the Southwest Pacific campaign offers an important demonstration of the effectiveness with which Army and Navy cooperation may be achieved under the existing system of direction by independent War and Navy Departments. The writer's familiarity with the Southwest Pacific area led him to select the work of the Seventh Fleet Seabees for description, although it was no more important, extensive, or spectacular than the work done by the Seabees of other fleets in other areas, and possibly may be less so.

The Seventh Fleet operated in the so-called Southwest Pacific area which, although its boundaries were modified from time to time, comprised essentially Australia, New Guinea, and nearby islands to the northeastward, the Celebes, Moluccas, Philippines, British and Dutch East Indies, and the waters surrounding and separating them. A large part of the Southwest Pacific, as thus defined, lies beyond the geographical boundaries of the Pacific Ocean, and the entire area is at a great distance from the United States and even Hawaii. In fact, the center of the area is as far from Honolulu as Tokyo is from San Francisco.

In this large and distant area, General Douglas MacArthur, as area or supreme commander, headed a staff which planned, co-ordinated, and directed the activities of Allied Land Forces, Air Forces, and Naval Forces, each of which included Australian and, in some cases, British and Dutch units. The Land Forces and Air Forces were commanded by generals and the Naval Forces by an admiral. Each commander was assisted by a staff and each command was of such size as to require subdivision into units which were headed, in the



Pontoon wharf at Los Negros serves to unload the S.S. Peter Cooper Hewitt *at the height of hostilities in the Pacific.*

Official Photograph, United States Navy

case of the Land and Air Forces, by general officers, and in the case of the Naval Forces, by officers of flag rank. The commander of the Allied Naval Forces was also the commander of its dominant component, the Seventh Fleet of the United States Navy. This fleet, as finally organized, comprised the Seventh Amphibious Force, submarines, cruisers, and aircraft of the Seventh Fleet, and a Service Force.

The Construction Battalions, the Seabees, were part of the Service Force, the commander of which was responsible for the logistic support of the fleet including the construction and maintenance of its bases. The Seventh Fleet possessed neither battleships nor aircraft carriers, but ships of these types from the South and Central Pacific Fleets operated with it as occasion demanded.

Southwest Pacific Objective

The basic mission of the Allied Forces of the Southwest Pacific was to halt the Japanese advance that threatened Australia and, if possible, to recapture the Philippines and the East Indies. It was decided that this could best be accomplished by an offensive along the north coast of New Guinea, culminating at the earliest possible date in the recapture of the Philippines. By the recapture of the Philippines, Japan would be effectively cut off from Java, Sumatra, and other highly productive islands of the East Indies, the seizure of which could therefore be postponed for subsequent mopping up operations. An offensive along the north coast of New Guinea could furthermore be co-ordinated readily and effectively with a series of thrusts toward the Japanese homeland by the Central Pacific Forces and would protect their southern flank while so engaged.

It was evident that the campaign would entail the construction of a number of bases at which ships, men, and equipment might assemble for offensive operations and from which they might subsequently be supported. The entire Southwest Pacific area was much too distant to permit fleets or armies operating within its boundaries to be effectively supported from existing ports and bases of the United States. Furthermore, the Southwest Pacific area itself was of such size that the well-developed Australian ports of Melbourne, Sydney, Brisbane, Adelaide, and Perth, and the smaller ports of Townsville and Cairns could be used effectively as bases for only the opening operations of the campaign. Before Japan surrendered, the Seventh Fleet Seabees had participated in the construction of no less than 30 bases in Australia, New Guinea, and nearby islands, the Admiralties, Celebes, and Philippines. These bases ranged in size from mere section bases, which provided little more than headquarters for the senior naval officer ashore in a forward area, to huge fleet bases which were capable of supporting a major task force. A base of the latter type, built at Manus in the Admiralty Islands, was characterized by the amazed British as "bigger than Scapa Flow," and an even larger one was nearing completion at Leyte Gulf in the Philippines when Japan surrendered. Each of these fleet bases was manned by a force of more than 50,000 men and officers and each possessed the industrial, hospital, storage, and miscellaneous facilities of cities of several times that population. In addition, the fleet bases provided means for dry-docking and repairing vessels of all types, not excluding the largest ships afloat. The *Missouri*, or for that matter, the *Queen Elizabeth*, could have been dry-docked in the largest of the sectional floating docks at Manus or Leyte Gulf.

The expeditious provision of these bases naturally required that their actual construction be preceded by effective planning. "Planning" is here used in the broad sense which covers a much wider field than the mere preparation of drawings and the writing of specifications. The planning of the Seventh Fleet bases was initiated in neither the Construction Forces nor the Service Force but by the commander of the fleet and his staff, for they alone knew enough of the over-all plan of campaign to determine the locations at which bases would be required and the nature and extent of the facilities needed to support the operations which would be launched from, and supported by, each base. It was the function of the Planning Division of the Seventh Fleet staff, and more particularly its naval base section, to analyze the functions of contemplated bases, to prepare preliminary specifications for their construction, to deal with general

headquarters in co-ordinating the construction program of the Seventh Fleet with that of other Allied Forces of the Southwest Pacific command and to assist general headquarters in co-ordinating the construction programs of the Southwest, South, and Central Pacific commands. Admiral Kinkaid, the commander of the Seventh Fleet, fortunately had on his staff as Planning Officer, Captain David S. Crawford, U.S.N., who ably directed this important work, assisted by Captain John E. Dingwell, U.S.N., head of the Naval Base Section of the Planning Division. The Naval Base Section also included Captain Hunt V. Martin of the Civil Engineer Corps and other Civil Engineer Corps officers whose long experience in construction work and intimate knowledge of its problems made them invaluable members of the Seventh Fleet staff. Preliminary specifications originating in the Naval Base Section of the Seventh Fleet staff would later be developed by the Planning Section of the Construction Forces into drawings and specifications which, after approval by the commander of the Service Force, and Admiral Kinkaid, would be issued to the construction organization assigned the task of building a base.

Conference

During the early stages of developing plans for an important operation, Admiral Kinkaid would usually give information to the commander of the Service Force as to contemplated demands on the various divisions of his organization. Members of the Seventh Fleet staff would also be authorized to discuss matters of mutual interests informally and confidentially with their opposite numbers on the Service Force staff. It was in this way that the commander of the Construction Forces and his principal assistants generally learned of the important tasks facing the Seabees. Although the resulting conferences frequently became heated, they had the merit of revealing at least some of the weaknesses of contemplated plans, and the conferees invariably parted friends in spite of the frank opinions they might have expressed as to each other's ability, or inability, to evaluate situations and forecast probable developments. An attempt to reconstruct one such conference will show what is meant.

The initial strike at Manus had been made in late February, 1944, and it was in early March that Captain Dingwell of the Seventh Fleet staff asked for an appointment with executives of the Construction Forces to discuss coming operations. The hours before Dingwell's arrival were spent in a final review of plans and specifications for the construction of a base of some importance at Madang, a Japanese stronghold which the Southwest Pacific Forces were scheduled to attack and seize in late June. Much time and effort had gone into the Madang plans for the place had one of the few good harbors on the north coast of New Guinea and would be most useful to the Seventh Fleet during the Southwest Pacific campaign against Wewak, Aitape, Hollandia and other enemy strongholds to the westward while the Fleet Base to be constructed at Manus was placed at the disposal of Central Pacific Forces operating farther to the north.

"We have the Madang plans all ready for approval," Captain Dingwell was told when he arrived.

"Congratulations," replied Dingwell, "and now," he added with a wry smile, "you can lock 'em up in the vault. The Madang show's off!"

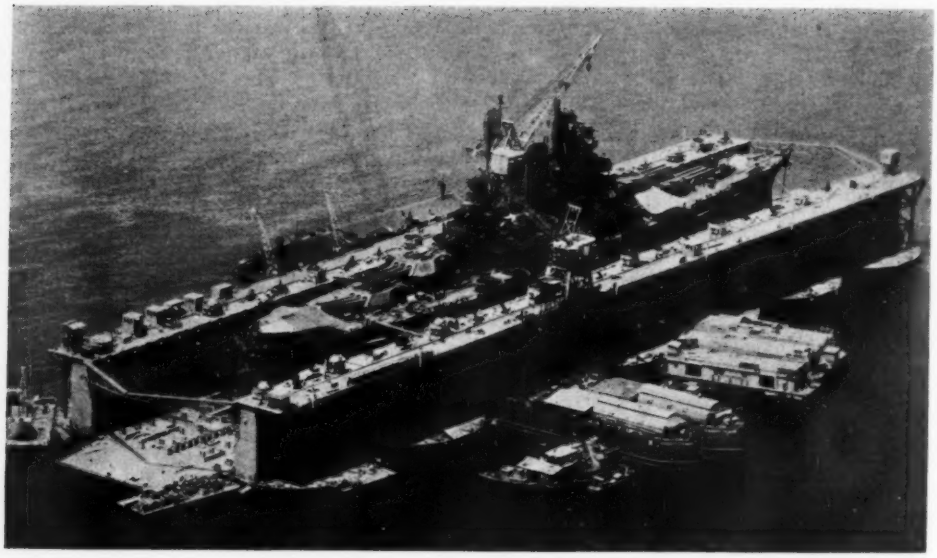
There was a moment's silence. — Off! The Madang show off! All that work! All that wrangling with the Army and Air Forces for the good sites! General headquarters had even tentatively agreed that the Navy could occupy the village and the best wharf! And now the whole thing was called off!

"I needn't say this is 'top secret'," went on Dingwell by way of explanation, "but we're to attack Hollandia in late April instead of Madang in June. We have information that the Japanese are pulling out of Madang and trying to concentrate at Wewak. The attack on Manus knocked them off balance and we're going to keep them that way by hitting Hollandia before they can reorganize. We're to take Aitape and Wake Island at the same time as Hollandia. Madang and Wewak are to be by-passed."

"Our necks will be out a long way! How far west of our Finschhafen base is Hollandia? How much of a base do we build there? Where do we get the men and materials?" The questioner was Commander Herd of the

The ship repair unit at Manus, where damaged ships were repaired for return to action, acquired many of the characteristics of a busy navy yard.

Official Photograph, United States Navy



The U.S.S. Mississippi in a floating dry dock for repairs at Guiuan anchorage at Samar Island. The dock was intended for cruisers, but by pumping 700,000 gallons of fuel oil out of its tanks, the giant ship was safely lodged in the keel blocks. It was the first battleship to be docked in the Philippine area.

Official Photograph, United States Navy

Construction Forces, who didn't like staff duty and wanted to take charge of a Seabee regiment in a forward area — an ambition he realized more than once before Japan surrendered.

"Hollandia's a little over 500 miles from Finsch," replied Dingwell. "It's a trifle closer to Manus, but Manus won't be ready to support a new operation next month. Anyway, we're building Manus for the Central and South Pacific Fleets in accordance with their plans and with Seabees and materials they furnished, so we'll have to launch the Hollandia show from Finschhafen and Milne Bay. We'll use men, materials, and equipment you had earmarked for Madang. The Hollandia base will be about the size of the one at Milne Bay, in fact a bit smaller, for there will be no advance base construction depot, no pontoon assembly depot and no spare parts depot. But Shanley has our first stab at a list of units. Read it to us, Mike."

Commander E. M. Shanley, who was then on the Seventh Fleet staff and had accompanied Dingwell to the conference, produced his list and began reading it with explanatory interpolations. "The ship repair unit is to be an E-3, equivalent to a destroyer tender. There'll be a repair wharf 500 feet long, 14 shop buildings 40 feet by 100 feet, and barracks and a mess hall for 800–1,000 men and perhaps 30 officers. The storage unit is a D-2 augmented to provide 80 storehouses 40 feet by 100 feet and about 20,000 cubic feet of cold storage. It's to have one wharf 40 feet by 500 feet."

Commander Wright, then Planning Officer and later Executive Officer of the Construction Forces, had been looking at a chart of Hollandia Harbor and interrupted at this point. "That'll have to be a marginal wharf, Mike, there's no room for a pier, and we'll not be able to have more than one Liberty ship alongside at a time. We can't use all those warehouses effectively with only one Liberty berth. Better let us put in two."

"We can't get the material for a second wharf. They'll have to lighter a lot of cargo at first and we'll authorize a second wharf as soon as lumber is available. Perhaps the battalions can cut piles and timber locally the way they did at Milne Bay," Shanley explained.

"Perhaps, but I hope we can get 'stateside' creosoted piles. The borers will eat off untreated piles in less than six months," replied Wright.

"We'll be on our way to the Philippines before that," Shanley countered.

"Maybe some of us will," said Wright, "but there'll be Seabees left behind in New Guinea to 'roll up the rear' and ship it forward, the way we're doing in Australia, and the Seabees will need those piers. But go ahead, Mike, any more storage and supply facilities? What about the hospital?"

Shanley continued, "There's to be a tank farm — eleven 10,000-barrel tanks, probably at Tanamerah Bay, 30 miles west of Hollandia. The hospital will have 500 beds to start with and will later be expanded to 1,100. We've got to have buildings for the operating rooms and 200 beds ready by the middle of September to take care of wounded from an offensive."

"What else?" queried Wright.

"Oh, the usual aggregation of small units. A fleet post office, small boat repair unit, harbor entrance control, and so on. Here's a bigger one, though. We need accommodations for an advance echelon of Admiral Kinkaid's staff," Shanley added.

"How big is it to be? Where is it to go?" asked Wright.

"Well," began Shanley, with some hesitation, "they're talking about accommodations for about 800 officers and men alongside General MacArthur's advance headquarters. Members of his staff think they will locate on the hills overlooking Lake Sentani. That will be handy to the air strips, you see."

"We'll plan for 800," remarked Wright, dryly, "but you'd better get a site big enough to hold the entire staff, that is, legal, personnel, medical, supply, and communication officers, and radio operators, yeomen, cooks, bakers, barbers — all 2,000 of them. And when we're talking about personnel, what about the receiving barracks?"

"We'd like you to use a tent camp for that," replied Dingwell, "but there won't be space so we're authorizing 20 barracks holding 250 men each — that's 5,000 men — and two mess halls and *(Continued on page 366)*

Human Relations in Industrial Civilization

Subject to the Forces of Isolation, Opposition, and Special Interests the Individual Finds It Difficult to Become a Significant Human Being

By Paul Meadows

It is fashionable in anthropological quarters to describe human relations in an industrial civilization by comparing them with those of preindustrial peoples. Thus, village life in Guatemala may be compared with the city life of industrial "Middletown" in some such terms as the following. Guatemalan villagers are fairly immobile, family-centered, with developed and transmitted rituals for nearly every daily or unusual occasion. Their pattern of living is smooth, personal, simple, concrete, and homogeneous. The motives of their lives respond to the sanctions of the sacred and the customary, while piety and the secular concerns inextricably intertwine in their daily living.

In glaring contrast is the life of Middletown Americans. Middletown ways are secularized, mobile, heterogeneous, conventional, and dominated by pecuniary valuations and advantages. Personal life hardly centers around the family, but rather is qualified and conditioned by a network of formal institutions. The sacred is weak and ineffectual, sometimes even nonexistent, and the comfortable routines of religious ritual are things apart from daily interests. The culture, although resting upon the natural environment, is not of it. The continuity of existence with the historic past and the unquestioning dependability of a personalized culture belong to other and happier days. Opinion, frequently dogmatic, is charged with differences and hostilities, strangeness and hate; it is too seldom just and reserved.

Almost two generations ago a great religious leader sensed this mood and temper of human relations in industrial society and wrote about it in his justly famous *Rerum novarum*. Said Pope Leo XIII: "The elements of a conflict are unmistakable. We perceive them in the growth of industry and the marvelous discoveries of science; in the changed relations of employers and workingmen; in the enormous fortunes of individuals and the poverty of the masses; in the increased self-reliance and the closer mutual combination of the labor population; and, finally, in the general moral deterioration." Leo XIII was by no means the first to feel the leaderless drift of the twin forces of isolation and opposition within industrialism. David Ricardo had spoken of the conflicts of landlord and tenant, of agriculture and manufacturing. Karl Marx had systematized the oppositions in his terrific ideological onslaughts. The utopian socialists of the Nineteenth Century, the Owens and Rauschenbusches, as well as the humanitarians, had been sorely perplexed by them. Today, whatever else industrial culture may contain by way of promise of peace and human fulfillment, it rests uneasily upon mobile foundations of isolated and opposed interests. Industrialism has both atomized and organized human relations, and this contradiction makes it tragically mercurial, volatile, and unmanageable.

Conflicts of Ownership

The oppositions show most markedly in the area of industrial operations. Here the stakes are high; they include control over men and machines, the direction of the amount and flow of income, compensatory leisure and differential sharing in the goods of life, the authority over resources, and the right to determine policy. Common interests are few if for no other reason than that human relationships to and in the system of massed mechanization are not uniform. As a matter of fact, so great has become the differential sharing in social life that the human being in industrialism is pushed first one way and then another on a gridiron of claims and counterclaims. The net consequence is shifting conflicts which weaken loyalties, confuse issues, exploit community ties,

Photo by Nathaniel Field from Ewing Galloway

The ways of industrialized people are mobile, heterogeneous, conventional. Industrial culture rests uneasily upon the mobile foundations of isolated and opposed interests. The human being is pushed first one way and then another on the gridiron of claims and counterclaims.

upset expectations, and create anxieties. These conflicts have a number of distinct patterns. The most important of them seem to center around the explosive questions of ownership and of industrial relations, as management-labor problems have come to be called.

Conflicts over ownership are ancient, but the form which they have taken under conditions of industrialism are historically novel. Absentee ownership, for example, was a central principle of the agricultural feudalism of medieval Europe. Great areas of land and people were often held in fief and subject to the fixed charges and decisions of distant masters, represented by a graded series of subordinates. Unlike its modern counterpart, agricultural feudalism was built upon an intricate and respected set of reciprocal rights and duties which extended from the lowliest villein to the highest lord. On the other hand, industrial feudalism is a creation of the pecuniary complex; it is a one-sided structure of demands, expressed in expectations of continuing money-income at whatever cost to physical or social or human resources. Its philosophy is unadulterated colonialism in which wealth and talent are drawn off to its metropolitan centers of power and influence while its hinterlands are drained of initiative and enterprise. The same dramatic themes are enacted over and over. The concentration of authority, the debauching of politics, the fraudulent misrepresentation of values, the corruption of communities, the desiccation of initiative have become commonplace.

Big Business and Small

Another conflict of industrialism which is bitter, widespread, and ominous is that between small and large businesses. American industrial history has been filled with it from the 1860's on. The steady march toward increased size was made possible by conquests over nature and the small man. Combinations, conspiracies, cut-throat competition, and corruption have been significant, powerful tools of massed mechanization. Little business is still the rallying-cry of industrial peoples with democratic dreams. At the same time, trust-busting is still an altar of sacrifice on which an occasional corporate goat is laid to appease a wrathful public. The language of small business employs the vocabulary of classic industrialism. Its phrases and word magic are picked up by the big and successful enemies of small business who delight in using them as a cloak for their own operations. For in our day the omnipotent State is no respecter of persons, and the large and small must bow before the mysterious providence of its own manifest destiny. Even in those places where big business has not fallen on the evil days of Fascism, it reads with alarm the handwriting of successive social legislations which redefine the authority and curb the excesses of business. For this reason, big business seeks safety behind the protective coloration of the little man. "Freedom of enterprise" becomes a line of defense — for bigness.

Less articulate, perhaps, and certainly more diffuse, but hardly less emotional, is that conflict which goes on between nonowners and owners of industrial enterprise. Marx wrote of it as a conflict between tool-less labor and tool-owning capital. Perhaps it is. But its backgrounds lie among the resentments felt by any creative people who know that their prospects for private property in production technics are poor if not hopeless. In any case, the remedy is not likely to be that

H. Armstrong Roberts

The sacred is weak and ineffectual, and the comfortable routines of religious ritual are things apart from daily interests.

proposed by Marx. On the face of it, abstract, collective property ownership in place of a no less abstract, corporate property ownership does not seem to mean a profound revolution for nonowning industrial people. Yet collective ownership has been the goal of most Left-Wing political movements for a century. It has made moderate headway and in one country has been completely adopted. It should be clear, however, that the difficulties and evils of an industrial culture change only their names when that culture moves from individual abstractness of property to collective abstractness. The sharp dichotomy between a capitalist and a communist industrialism is a pathetic, if pleasurable, self-delusion.

The conflict between owners and nonowners, between those who have and those who have not, has its origin in a moral assertion of the right to property. Property ownership is a human and social institution protected and promoted by even the most primitive peoples. Our moral insight tells us that on such rights alone can be built an enduring, human personality and social structure. A society whose property aspirations are blocked is not secure; its mood is dangerous, and its morale needs the emotions of nationalism, or some other displaced aggression, to canalize its frustrations. Marx sought to lift this moral sensitivity onto the plane of depersonalized dialectics to win for it an irrefutable cogency which it does not have. But while Marxists were busy spinning their web of a philosophy of history, social protest movements were whittling away at the in-

Photo by Caterpillar Tractor Company

Their pattern of living is smooth, personal, simple, and homogeneous. The essential job of production is one of collaboration.

dustrial system with such reforms as would maintain, if not enlarge, the sphere of personal jurisdiction over production. This is the story behind the social legislations of the past two generations. In our day "have not" is a fighter's phrase, not of a people seeking a cash dole but of those who hope to achieve a just and honorable property system which provides for all men a means to express their being. The leadership of industrial societies dare not temper with the emotions which are aroused by those who picture themselves, with or without just cause, in the "have not" camp.

The Protest of Labor

Without any doubt the storm center in industrial life is the conflict between labor and management. Here opposition in industrialism loses any vagueness and lack of direction it may have and becomes overt, organized, and engineered. Its vehicles are the labor union and the employers' association. Both have developed in order to safeguard and advance special interests. At times, both have drawn a hard and fast line between their worlds, have declared war on each other, and have been forced to negotiate peace. Both make overtures to the general public and both have recourse to government but, unfortunately, neither is fully prepared to confess a community of interest between them.

The labor movement has been a protest movement. Its objects of concern have grown out of the contractual wage status, the depersonalized and massed relationships of industry and the propertyless and unprotected position of labor as a commodity bought and sought in a changing market. Violent when provoked, and occasionally revolutionary, organized labor has been primarily a business-like response to a businessman's civilization. The labor movement, an outgrowth of the mass phenomena of industrialization, is also an expression of the several technological interests and roles of the industrial worker. In many ways, unionization and its attendant activities represent the introduction of civil rights into industrialism. It aims to establish an industrial jurisprudence made imperative by failures in the bargaining procedures, by the black-listing, espionage, paternalism, and superior economic strength of employers' associations. But although grown up, organized labor has still to mature, to come of age. It cannot forever be on the receiving end, making demands without also giving concessions. It is apparent to all observers that in terms of economic and social resources, organizedla bor is now a peer of corporate business.

From the standpoint of advanced management and possibly of an informed public, a strong labor movement is no longer an unmixed evil. Management is swinging to the view that the industrial worker is not a machine but a customer, not a commodity but a citizen, not an operative but a person. The business of management is agreement. The essential job of production is one of collaboration. Human beings, though not to be regarded as machines, must have a machinery of social adjustment. In order to operate effectively, the technical organization of production must rest upon a community organization which is free to operate efficiently. The values, which the enlightened industrial statesmanship of a George Johnson or a Chester Barnard are realizing and promoting, are in the last analysis precisely what an enlightened labor leadership has been urging upon industry for two or three generations. One of the most heartening signs of our time is the gradual, even if limited, acceptance of labor-management councils, personnel departments, labor-management forums, worker education, and similar ideas, as the folkways and mores of industrial production. Nothing could be more effective in reducing the risks and incidence of industrial war.

Human Insignificance

Many students of modern society are inclined to regard labor-management and other such conflicts of industrialism as the fruit of isolation, rather than of innate differences of interest. They point to the mobility and the distance of human contacts which industrialism has stimulated. They emphasize particularly the specialization of the productive processes and point out that division of labor induces bondlessness, except in the narrow, self-centered, horizontal economic interests. In no other society, they contend, has the individual found it so difficult to become a significant human being, and in no other society is community of interest and purpose so improbable, if not impossible. Difference is aggravated by deprivation of social impulses, and opposition springs from the fragmentation of social experience and the impoverishment of mutual understanding.

The explanation of this situation seems to lie in the industrial community. Human relations are formed in, and expressed through, the community. Much of the impact of industrialism upon human relations has been

Property ownership is a human and social institution protected and promoted by even the most primitive peoples. Our moral insight tells us that on such rights alone can be built an enduring structure.

Photo by W. Eugene Smith from Black Star

delivered by way of this organization for living. While perhaps not inevitable, the transformation of community life by industrialism has been far-reaching, if not devastating. Indeed, the keen interest in community study of the last 25 years grew directly out of the concern over community disarrangement as a result of industrial misorganization. Community life of today has pathologies which, although not unique historically, are certainly more common and aggravated than at any other period. For into the pattern of the community, industrialism has built walls which isolate, highways which accelerate, and dead-end streets which frustrate human relations. The fast-moving stream of human contacts turns out to be a shallow volume of socialized life; forms must do the work of impulses, while mass gains the significance which rightfully belongs to individuality. In no place have human ends become so lost and subordinate to human means as in the crowded modern industrial city. The city becomes the prototype of the industrial group; it is large, impersonal, mechanical, and unwieldy.

Cities of Industry

The urban system has been the twin of the factory system, and neither could have survived without the other. They are both the fruit of massed mechanization. Industrial society has nullified the small, face-to-face primary groups: It has seceded from the union of intimate and direct associations, and it has set up a confederacy of loosely organized, autonomous interest groups. As a result, it has plunged human relations into a civil war of incompatible, uncomprehending, and contending social forces. As in all warfare, it is the individual who pays the price of victory and defeat, and the subtle nuances of individual social expression are overwhelmed by the strategies demanded by commercialized groups. The individual becomes a partisan of mass organizations which deal in harshly drawn and ill-understood issues.

The carrier of this culture has been industrial metropolitanism. Of course, there have been great cities before in history, and wherever they have appeared, life has revolved around them. But the modern metropolis is something new, and it is a place of strange and disturbing paradoxes. The organization of its life is centralized and hierarchical, but its spatial pattern sprawls designlessly. The metropolis concentrates huge, mixed segments of population, but it fosters social distances among its people. It has been both responsible for, and the product of, an incredible multiplicity of interests, but the life of the average individual citizen is plain and unattractive. A remarkable level of material success has been made possible, but the physical structure of metropolitan existence is shabby, ill-kept, costly, monotonous, and barren.

The industrial city has been built upon the technological conquest of space, and yet its perennial problem is one of congestion. Its growth has been quickened by the economic calculations of profit and loss; but the city is an expensive investment with its assets frozen and its future bound by complicated credits and speculative ventures. There is a fantastic range of personal incomes and mass poverty amid the scene of tremendously rich operations. The city is the product of engineering and yet no engineering entered into its over-all expansion.

The paradoxes of the modern industrial city extend beyond its economic aspects and reach into the philosophic, cultural, and human aspects of society as well. The metropolis is maintained by a diversely talented population whose individual members, seldom achieving status as significant human beings, are content with narrow specialties and spectator enjoyments. Among its people there is little philosophic insight into the values of the new way of life which the city makes possible. The extent and variety of occasions for human contacts have been greatly magnified, but there is no ritual or mediating device for those contacts except specialized interest or cash. Education for group life is barren and dry. The populace becomes a seething mass in search of externally applied pleasures as opiates for its inability to find substance within. The metropolis (*Concluded on page 364*)

A Study of Man Embracing Error

Fossilized Skeletons of Prehistoric Man Serve to Remind Us that Prejudice Has No Place in Science

By M. F. Ashley Montagu

OSCAR WILDE, in *The Picture of Dorian Gray*, makes one of his characters say: "I wonder who it was who defined man as a rational animal. It was the most premature definition ever given." In his delightful *Desert Islands*, Walter De La Mare refers to *Homo sapiens* as "raw *homo*, that is, with little admixture of *sapiens*." For he who would be wise should be careful. This is particularly true of the study of *Homo sapiens fossilis* by *Homo sapiens recens*.

In the study of prehistoric man there have been plenty of opportunities for the perpetration of deliberate hoaxes. The stretches of time dealt with are long, running into hundreds of thousands of years, the character of the remains are often uncertain, and the beds from which they are recovered are so frequently untidily disarranged that the greatest of authorities may sometimes be deceived. They are not, however, usually deceived by the deliberate hoaxer, who, for lack of the necessary specialized knowledge generally stands very little chance of succeeding. Possibly for this reason there have been very few attempts at deliberate hoaxes in the study of prehistoric man. The deceptions that have been perpetrated fall into the class of simple errors due, in almost all cases, to overenthusiasm, but also, in not a few cases, to ignorance.

Prejudice Injected into Science

Like other men, scientists are not immune to prejudice: They tend to be least immune from the action of their prejudices when they are least aware of them. Scientific method really amounts, as P. W. Bridgman has said, to doing intensely one's very best with one's mind. A person, it may be added, is not necessarily a scientist because he uses the methods of science, but that person is a scientist who uses any reasonable method in a scientific manner. A fair sprinkling of students of prehistoric man have used the methods of science somewhat unscientifically, and, in a number of cases, the errors into which they have thus been led have even yet been uncorrected and circulate in the debased coinage of an earlier day.

In the days when ignorance and prejudice combined to limit the age of the earth to 6,000 years, and the vice-chancellor of Cambridge University, Dr. Lightfoot,[1] put the creation of the earth at exactly 9:00 o'clock in the morning of October 23, 4004 B.C., it was believed by the orthodox that man had been created in a state of physical perfection by a single act. Therefore, it was inconceivable that there should lie hidden anywhere in the earth's crust the fossilized remains of early men. Up to the time of Lightfoot's death, no fossilized human remains had been turned up to challenge orthodox belief.

Contradictory to Dr. Lightfoot's estimate and the Biblical account of creation, fossil remains had indeed been discovered earlier than 100 years ago. The bones were described as those of *Homo diluvii testis* — "Man, witness of the Flood." This notable discovery was due to Professor Johann Scheuchzer of Zurich who, in 1726, described the remains[2] as a "rare relic of the accursed race of the primitive world," and exclaimed piously: "Melancholy skeleton of an old sinner, convert the hearts of modern reprobates!" Unfortunately, this rare relic of ancient man was later shown to be nothing more than

[1] John Lightfoot, D.D., (1602–1675). See his *Prolegomena* in Pitman's edition of *Lightfoot's Works*, London, 4:64, 112 (1822). "Heaven and earth, centre and circumference, were created together, in the same instant, and clouds full of water, . . . this work took place and man was created by the Trinity on the twenty-third of October, 4004 B.C., at nine o'clock in the morning."

[2] Scheuchzer, Johann. Scheuchzer's *Homo diluvii testis* is now on display in the Taylor Museum at Haarlem.

American Museum of Natural History

Skulls of prehistoric man. In usual reading order are the remains, partly restored, of Piltdown, Neanderthal, Cro-Magnon, and Pithecanthropus skulls.

American Museum of Natural History

Did Neanderthal man really look like this reconstruction? Where the slightest degree of likeness is the criterion of exactness, it is impossible to reconstruct the facial appearance of extinct men from their skulls. The expression of early man was probably no less benign than our own.

the fossil remains of a giant salamander. But disclosure of the true nature of the remains had not been made before the fossil had enjoyed great celebrity and had been visited by thousands of awed pilgrims.

Meanwhile the fossil skull of a truly ancient man, which had been discovered at Cannstatt in 1700, rested peacefully on the shelves of the Stuttgart Museum for the next 135 years, undisturbed, undescribed, and unrecognized for its true worth.

The first skull of Neanderthal man was discovered at Gibraltar in 1848, but it aroused absolutely no interest, and remained undescribed until 1907. The skullcap found at Neanderthal in 1857, from which the name of this type of skull is derived, was said by the great Rudolf Virchow to be that of an idiot, a pathological specimen. Another savant declared it to be the top of the head of a French prisoner of war, deposited by some mischance in the cave in which it had been found. But there were other men, like King,[3] Huxley,[4] and Schaafhausen,[5] who were convinced, as their writings show, that this skullcap was that of an ancient man. Their views, however, received very little credence, and the leading character in the drama was persistently kept from making his appearance on the stage.

Prehistoric Relics to Order

During these years, Boucher de Perthes,[6] a customs officer from the small town of Abbeville, France, was engaged in excavating caves and searching all sorts of likely places for the remains of primitive man. Boucher had had the good fortune to recover many stone implements which he was convinced could only be the work of man. Unfortunately the only evidence capable of clinching his argument and effectively convincing others of its truth was lacking, namely, the fossil remains of man himself. Boucher therefore was determined to find that evidence.

It was his custom to reward the workmen of the gravel pits with a gift of two francs for any axes they might find and bring to him. He now made the offer of 200 francs for the first fossil remains of ancient man to be found. This offer stimulated the workmen to keep a more careful lookout but it also stimulated some of the men to ingenious legerdemain. Boucher's rewards had already had that effect on a two-franc basis. An old resident of Abbeville tells the story that, observing a workman striking flints in front of his door one day, she asked him what he was doing. The workman replied: "I am making Celtic axes for M. Boucher de Perthes!"

A race ensued among the workmen, each of whom wished to receive the reward, and, of course the inevitable happened. On March 23, 1863, one of the workmen brought Boucher two flint axes and a human tooth which he said he had found in the pit at Moulin-Quignon. Further work in the pit under Boucher's supervision led to the discovery of several more axes and teeth, and, most priceless of all, a jawbone which differed, in Boucher's expectant eyes, from that of contemporary man.

News of the discovery traveled around the world and gave rise to heated controversy. Many visitors came from abroad to view the famous pit among whom was the English archaeologist, John Evans.[7] Evans obtained permission from Boucher to send over a specialist named Jean Keeping to examine the pit in detail.

The first thing that Keeping did was to give the workmen a holiday for a few days. Then he went to work. He found that the axes were forgeries; that they had been recently inserted into the sides of the pit, as the disturbed earth clearly revealed. He found, in short, that M. Boucher de Perthes had been deceived. It soon transpired that the jawbone, probably of some Gallo-Roman or Celt, had been brought to the pit from a surface site some distance away from which it had been recently recovered. The extent to which authenticity was attributed to the jawbone may be judged from the fact that the most learned professor in these matters in France, M. de Quatrefages,[8] read a paper before a learned society who

[3] William King (1809–1886), Professor of Geology, Queen's College, Galway, Ireland. "The Reputed Fossil Man of Neanderthal," *Quarterly Journal of Science*, 1:88 (1864).

[4] Thomas Henry Huxley (1825–1895), Professor of Natural History, Royal School of Mines, London. *Zoological Evidences as to Man's Place in Nature*, London, 1863.

[5] D. Schaafhausen, Professor of Anatomy, University of Bonn. "On the Crania of the Most Ancient Races of Man," Muller's *Archiv.*, p. 453 (1858); translated by George Busk in *Natural History Review*, London, April, 1861.

[6] Boucher de Crèvecoeur de Perthes (1788–1868), French archaeologist. *Antiquités Celtiques et Antédiluviennes*, 1847–1864. See Volume I, *De l'Industrie Primitive ou des Arts à Leur Origine.*

[7] John Evans (1823–1908), English archaeologist and paper manufacturer. *The Athenaeum*, July 4, 1863.

[8] Jean Louis Armand de Bréau de Quatrefages (1810–1892), French anthropologist. *Rapport sur le Progrès d'Anthropologie*, Paris, 1867.

accepted this remarkable jawbone as being completely authentic. Perhaps the reputation of M. de Quatrefages was so thoroughly established that the members of the society dared not question his authority.

Poor Boucher was unlucky. He remains the greatest archaeologist of his day and the most advanced. His enthusiasm for his subject and his courageous and intelligent conviction that the remains of fossil man must somewhere, sometime, be found together with his artifacts, caused him too easily to accept what he wished to find. The too-ready acceptance of the appearance of reality is a very old, a very human, and a very enduring weakness. Quite as old is the contrary failing; refusal to accept what one does not wish to see. Right into the Twentieth Century the claim to antiquity of the remains of undisputed fossil man have been rejected as ancient because they were found in deposits which the prejudices of some scientists would not admit. Such, for example, has been the fate of Galley Hill man, and of the skeletal remains discovered at Swanscombe, in England, about 1912. The latter are now lost, but in 1935–1936, in a nearby pit, the remains of another fossil skull of *Homo sapiens* were found, thus vindicating the honor of the earlier representative of what was probably a member of the same group.

How He Got an Ugly Face

When the accumulating evidence made it impossible any longer to deny that the group represented an extinct type of man, Neanderthal man was gratuitously endowed with a rather brutal social, as well as physical, character. Much was made of his overhanging brow ridges and absent chin. Interestingly enough, the fact that he had a larger brain than modern man, both absolutely and relatively, was strangely overlooked. When in 1911–1913, Marcellin Boule [9] published his reconstruction of the Neanderthal man found at La Chapelle-aux-Saints, he endowed the poor fellow with a bull neck, a stoop, a gorilla-like spinal column and knock-knees, principally because Boule felt that Neanderthal man ought to look like a brute. It goes without saying that such a brute deserved only to be exterminated, and so exterminated he was — by the anthropologists. This eugenic-Hitlerian *ausmerzen*, as the Nazis referred to the technique of race-extinction, was achieved through the agency of the race which succeeded Neanderthal man, namely, high-browed Cro-Magnon man, a man like ourselves. This notion fitted perfectly with the conception of "the survival of the fittest" creed held by so many Nineteenth-Century thinkers and their descendants who have survived into the Twentieth Century. And so poor Neanderthal man was exterminated.

Once more, accumulating evidence began to render this widely held theory somewhat dubious. In the light of the newer evidence, many a student still under 40 who once shared the orthodox view has found that Neanderthal man must have run away in order to fight another day. The evidence is now quite clear that Neanderthal man mixed with types like Cro-Magnon man and that we are the descendants of such mixed types. As a distinct type Neanderthal man became extinct only by being absorbed into the larger populations of *Homo sapiens*.

[9] Pierre Marcellin Boule, "L'homme fossile de la Chapelle-aux-Saints," *Annales de Paleontologie*, 6:112–172; 7:85–192; 8:1–70 (1911–1913).

Russians Reverse the Process

If one may judge from the reconstruction, by Russian scientists, of the Neanderthal child recently found in the Teshik-Tash cave in Southern Uzbekistan, the Russians have gone to the other extreme in humanizing maltreated Neanderthal man, for they have made the nine-year-old child look like a little Russian boy complete with retroussé nose.

Less excusable than Boule's reconstruction of Neanderthal man is the violence perpetrated upon the skeletal remains of Rhodesian man. As Professor Wood Jones [10] has remarked: "Probably no more somber practical joke has ever been played upon a human skeleton than that which Mr. W. P. Pycraft [11] perpetrated. For want of a little elementary knowledge of the normal anatomy of the human pelvis, Pycraft has lately condemned a perfectly upright representative of the genus *Homo* to masquerade as the type of a new genus *Cyanthropus*, since it 'walked with a stoop, with the knees turned outwards.'"

Such reconstructions are possible not only because of the want of an expert knowledge of human anatomy but also because of the somewhat naïve notions held by many persons concerning the physical traits of earlier forms of human beings.

Even less justifiable are the attempts to reconstruct the facial appearance of extinct men from their skulls. As Lander,[12] Wood Jones,[13] and Glaister and Brash [14] have shown, where the slightest degree of likeness is the criterion of exactness this is quite impossible of achievement. From a skull it is quite impossible to reconstruct the character of the hair, eyes, nose, lips, ears, eyebrows, skin creases, fullness, or expression. In short, it is impossible to reconstruct the appearance of the face. Nevertheless, such fancy reconstructions are to be found in almost every book dealing with the evolution of man. It is highly desirable that they should be dropped, for they do real harm. Their creators have endowed them with traits and expressions which follow the formula that the earlier or more primitive the type, the more brutal; the later the type, the nobler the expression. The probabilities are that the expression of early man was not less benign than our own.

Facial Reconstructions

As if in answer to these strictures, there appeared, after the main body of the present article was written, several papers on the reconstruction of the facial appearance of a dissecting-room cadaver from the skull.[15] These reports by Dr. W. M. Krogman are of considerable interest. Dr. Krogman measured the head of a cadaver in the customary anthropometric (*Continued on page 356*)

[10] Frederic Wood Jones, *Man's Place among the Mammals*, London, 1929, page 368.

[11] W. P. Pycraft, *British Museum Report on Rhodesian Man and Associated Remains*, 1928; and *Man*, December, 1928.

[12] K. Lander, "The Examination of a Skeleton of Known Age, Race, and Sex," *Journal of Anatomy and Physiology*, 42:282–291 (1918).

[13] Frederic Wood Jones, *Man's Place among the Mammals*, London, 1929, pages 363–365. See also H. von Eggeling, *Physiognomie und Schadel*, 1911.

[14] John Glaister and James Couper Brash, *Medico-Legal Aspects of the Ruxton Case*, London and Baltimore, 1937.

[15] W. M. Krogman, "The Reconstruction of the Living Head from the Skull," *FBI Law Enforcement Bulletin*, July, 1946; "Whose Skull Is It?" *Scientific Monthly*, 53:315–316 (1946).

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

Television Short Circuit

APPROXIMATELY 1,000 Alumni gathered at Walker Memorial on the evening of Saturday, February 8, for the mid-winter dinner meeting of the Alumni of Metropolitan Boston, at which was featured a demonstration of a complete television system — from performers' stage to the viewing screens of individual receivers.

Alumni gathered for dinner at Walker, and seating was arranged by classes to facilitate the renewing of old acquaintances. Upon conclusion of the dinner pleasantries, those in attendance smoked and chatted in the outer lounges while Morss Hall was made ready for the evening's program of addresses and television entertainment.

Harold Bugbee, '20, President of the Alumni Association, first introduced H. E. Lobdell, '17, recently appointed Executive Vice-president of the Alumni Association. He, in turn, introduced Dr. Everett M. Baker, new Dean of Students, who made a brief response. President Compton was then called upon to announce recent developments taking place at M.I.T.

In his usual inspiring manner, Dr. Compton spoke of the Institute's plans for the future, emphasizing the urgent need for buildings and facilities which will make it possible to grasp opportunities in education and research which have developed from war experience. He paid a warm tribute to members of the staff whose interest and energy are advancing M.I.T.'s program of reconversion to peacetime activities.

Keynoting the evening's activities was a paper, "Television — Retrospect and Prospect," delivered by Dr. Vladimir K. Zworykin, associate director, R.C.A. Laboratories. This paper, which The Review is happy to present on page 333 of this issue, discusses significant technical achievements in the development of modern television, and peers into the social significances which may be expected to accrue from the widespread visual entertainment and instruction when television programs are firmly established on a nationwide basis.

Under a program arranged by Professor John T. Rule, '21, and worked out in conjunction with engineers and program directors of the R.C.A. Laboratories, an interesting television program followed Dr. Zworykin's paper. Opportunity was given for those in the audience to witness all phases in the production of a television program — from the original action on the stage, through camera pickups and the complicated analysis, transmission, and synthesis of the visual image — to the black and white pictures on the screens of some two dozen receivers which were distributed throughout Morss Hall. The complete television circuit was no longer than a few hundred feet, and the audience had excellent opportunity to compare the image on the screens of the receivers with the stage presentation in "live talent."

In the program of television entertainment, Professor Albert A. Schaefer, Department of Business and Engineering Administration, acted as master of ceremonies. The program was designed to show the capabilities of television transmission, and included a demonstration of the effectiveness of fire extinguishers by Professor Arthur R. Davis of the Department of Chemistry, Hawaiian and ballet dancers, an exhibition of fencing, magician's tricks, and blackboard cartoon drawings by Francis W. Dahl of the Boston *Herald*.

For many who attended, this program provided the first opportunity to view television images of any sort; for a much greater number, it offered the unusual additional feature of a completely mobile pickup and self-contained distribution system enabling all essential steps in a television production to be witnessed simultaneously. But for all who were fortunate enough to be present, the demonstration was a truly entertaining and highly appreciated *pièce de résistance*.

Kurt Lewin, 1890–1947

PROFESSOR Kurt Lewin, director of the Research Center for Group Dynamics at M.I.T., and internationally known as an authority on group psychology, died suddenly at his home in Newtonville, Mass., on February 12, 1947.

A native of Mogilno, Germany, where he was born on September 9, 1890, he is survived by his wife and four children. Professor Lewin was educated at the University of Freiburg and the University of Munich, and was graduated from the University of Berlin with the degree of doctor of philosophy in 1914.

In 1932 Dr. Lewin came to the United States from the University of Berlin where he had been associate professor of philosophy since 1921. He served as a visiting professor of psychology at Stanford University from 1932 to 1933 and was acting professor of psychology at Cornell University from 1933 to 1935. From 1935 to 1944 he was professor of psychology at the University of Iowa and was appointed a visiting professor at Harvard University for one semester each in 1939 and 1940. Dr. Lewin had been a consultant to the United States Department of Agriculture since 1942 and to the Office of Strategic Services since 1944.

The appointment of Dr. Lewin as director of the Research Center for Group Dynamics at the Massachusetts Institute of Technology came in 1944, and the center was made a division of the Institute's Department of Economics and Social Science. It provides an integrated approach to a relatively new field within the social sciences and supplements the activities of the Institute's Industrial Relations Section. The research center was established through a grant of the Marshall Field Foundation of New York and Chicago, Inc., and received additional grants from the Commission on Community Interrelations, which is sponsored by the American Jewish Congress.

Assistant to Dean of Students

APPOINTMENT of James Lee Phillips, World War II veteran and member of the Senior Class in the Course of Business and Engineering Administration at the Institute, to the new administrative post of assistant to the Dean of Students, was announced in February by Dean Everett M. Baker. In this post Mr. Phillips will assist Dean Baker in contacts with students and their activities.

Announcing the new appointment, Dean Baker said: "Mr. Phillips' duties and responsibilities will be to serve as assistant to the Dean of Students in his responsibility for the Institute's relationships with student government and recognized student activities, including athletics and fraternities. It was because of Mr. Phillips' recognized leadership as chairman of the Interfraternity Council and his interest and activity in athletics that he was invited to fill this new position. It is assumed that the position will not be permanent but that from time to time, at intervals of two to three years, the assistant to the Dean of Students will change in order that the office will always have a representative of undergraduate interest and attitudes whose first-hand knowledge and opinions are immediately related to student affairs. The developing plans for increased emphasis on the improvement of living, recreational, and extracurricular activities of the Institute indicate the importance of Mr. Phillips' responsibilities." The new appointment is significant because of the close link it provides between students and the Administration at a time when the Institute's student body is much larger and of different composition than at any previous time.

For Meritorious Achievement

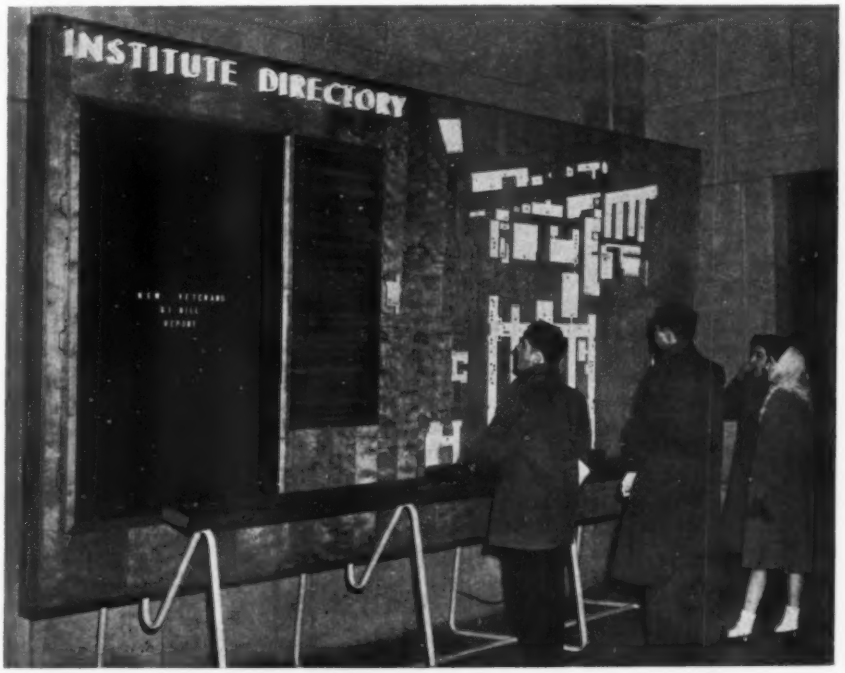
JAMES M. AUSTIN, Associate Professor in the Institute's Department of Meteorology, has been awarded the Medal of Freedom by the Commanding Officer of the United States Forces in the European Theater. The medal was presented to Dr. Austin in the presence of members of the staff of the Department of Meteorology with the following citation:

"For exceptionally meritorious achievement which aided the United States in the prosecution of the war against the enemy in Continental Europe, as Special Consultant, 21st Weather Squadron, Ninth Air Force, European Theater of Operations, from 22 April 1944 to 5 September 1944. He displayed great intelligence, thorough professional knowledge, and outstanding devotion to duty under adverse field conditions in developing forecasting techniques in the European Theater of Operations. While serving as one of the principal forecasters engaged in predicting the weather for the Normandy invasion and the Northern France campaigns, he, through his timely and expert advice and ingenuity, was highly instrumental in the success of those campaigns, thereby materially contributing to the final victory."

To Further Applied Mathematics

PRINCIPAL discussion at the meeting of the Visiting Committee on the Department of Mathematics * on May 31, 1946, centered on the strengthening of the work in applied mathematics, particularly at the graduate, or near graduate, level. As far as American science and technology are concerned, it is extremely important that this field be greatly strengthened as rapidly as possible. There is already active interest in the matter at a number of institutions, notably Brown University, New York University, Princeton University, and the California Institute of Technology. Because of its size, location, and pre-eminence, and because of the diversity of its engineer-

* Members of this Committee for 1945–1946 were: Frank B. Jewett, '08, chairman, William S. Newell, '99, Daniel F. Comstock, '04, Roy W. Chamberlain, '31, Hugh Dryden, Warner Eustis, and Joseph W. Powell.



To aid visitors and students in finding their way about the labyrinthian corridors of M.I.T., a large Institute directory has been installed in the lobby of Building 7 outside of the Information Office. This electrically operated directory shows, by means of a continuously burning red lamp, the location of the board. Reference to the directory will give the number corresponding to the major offices and departments, and by punching the number thus determined, the floor and position of the desired office are immediately indicated by the illumination of a small lamp on the scale model of the Institute buildings.

Class Reunions

Plans for reunions this year have been announced by secretaries of the following classes:

1877 June 14, luncheon at the Hotel Statler, Boston.
1882 Probably no reunion.
1887 The Class President has sent out a questionnaire and announcement of reunion plans will be made later.
1888 The usual annual dinner will be held in May but the time and place have not yet been decided.
1892 A reunion is expected but plans are not yet finally arranged.
1897 June 10–12 (tentative date), East Bay Lodge, Osterville, Mass.
1902 June 12–13, East Bay Lodge, Osterville, Mass., adjourning on the 14th for Alumni Day in Cambridge.
1905 June 13–15, East Bay Lodge, Osterville, Mass.
1907 June 20–22, Oyster Harbors Club, Osterville,
1912 June 6–8, East Bay Lodge, Osterville, Mass. Ernest W. Davis, chairman.
1917 June 6–8, Wentworth-by-the-Sea, Portsmouth, N. H. Chairman, W. I. McNeill assisted by H. E. Strout.
1922 June 13–15, Hotel Rockmere, Marblehead, Mass.
1927 June 21–22, East Bay Lodge, Osterville, Mass. Ezra F. Stevens, general chairman.
1932 June 7–8, Wentworth-by-the-Sea, Portsmouth, N. H. Thomas E. Sears, Jr., chairman.
1937 Reunion probably on Cape Cod a day or two prior to Alumni Day, with simultaneous gathering of classmates somewhere on West Coast. Anticipated that wives will be invited.
1942 Some form of reunion in Cambridge over the week end of Alumni Day, June 14. Details later.

Additional information will be available from class secretaries

ing interests and its unique technological facilities, M.I.T. is peculiarly indicated for leadership in this field, which is of the utmost importance to science and engineering.

Roughly speaking, the problems which confront the Department in strengthening this aspect of its program are three: attracting a competent staff, determining the best setup for applied mathematics within the structure of the Institute, and disseminating a better general knowledge of what the Institute is in a position to give.

The evidence indicates clearly that while the United States is presently rich in outstanding men in fundamental or pure mathematics, it is woefully deficient in such men in the field of applied mathematics. Consequently, there is intense competition for these few men, not only between educational institution but also, to some extent, between universities and industry. In all probability no institution will be able to secure all the first-rank men it should have to staff its department fully, and it will have to build its staff up gradually as younger men of ability mature and are attracted to the field.

While doubtless not unique in the Department of Mathematics, the problem of competing with the higher salaries paid in industry is certainly an important one of the Department's present needs. Probably nothing that can be done in this direction will alone suffice and there is consequently necessity for the Department and the Administration to do everything possible to provide opportunities and facilities which will attract men to the staff against the lure of higher remuneration elsewhere. Because of the strength of its scientific and technical departments, it would seem that M.I.T. should certainly be in a position to afford outstanding men a wealth of opportunity for creative work in mathematics, such as no other institution in the country could match. The Committee feels that basic to success is the full utilization of all the Institute's facilities to strengthen the work in applied mathematics.

There seem to be two possible ways of establishing work in applied mathematics within the Institute: (*a*) concentration of the work in the Department of Mathematics; and (*b*) dispersion of it in those scientific and technical departments which have major problems largely concerned with mathematics of an advanced character. In the latter case, the Department of Mathematics would serve as a central administrative department and professional meeting place for mathematicians interested in applications to problems of widely different character.

The Department should, if possible, plan a conference at the Institute in the summer of 1947 which would attract men who are interested in the development of applied mathematics and which would make better known the opportunities at M.I.T. for work in this field. The Committee feels that the Administration and the Corporation should support such an undertaking.

Navy Award

THE United States Navy Department, through the chief of the Bureau of Ordnance, has conferred upon the Institute's High Voltage Laboratory, the Naval Ordnance Development Award. This honor has been granted in recognition of the distinguished service of the laboratory to the research and development of naval ordnance.

In addition to the certificate for distinguished service to naval ordnance development which was presented to the laboratory, each member of the staff was presented with a lapel emblem, a symbol of appreciation for his services. Those who received these awards were Professor Robert J. Van de Graaff, director of the High Voltage Laboratory, and Professor William W. Buechner, '35, associate director; Professors Herman Feshback, '42, and Walter C. Schumb; E. Alfred Burrill, Jr., '43, Lloyd R. McIntosh, Everett W. Nickerson, Anthony Sperduto, '42, and Wilton A. Tripp.

Solar Energy Building

THE Institute has undertaken the construction of a small building to carry on experiments in the collection and utilization of the sun's energy to heat dwelling houses. A new approach is being investigated in which heat is to be collected and stored in walls forming a part of the south wall of the building. These walls may be either massive enough to store heat over short periods by a moderate rise in temperature, or they may contain a salt which melts at the normal temperature of domestic radiant heating panels and which stores heat in the process. To prevent heat loss to the outdoors, and at the same time permit absorption of solar energy, the walls are covered with double glass panes, and may also ultimately be provided with shades (*Concluded on page 352*)

BUSINESS IN MOTION

To our Colleagues in American Business . . .

There is an old and sound saying: "Be not the first by whom the new is tried, nor yet the last to cast the old aside." This expresses good common sense, especially in these days when so much that is new is being promised. But sometimes it is difficult to be properly cautious without running the risk of being too late. What is new is not necessarily better, nor what is old, either; the wise manufacturer demands proofs of both before making a decision.

Take the case of free-cutting copper, which Revere first began to supply during the war. Our metallurgical and practical tests proved to us that it would make possible faster and more accurate production of copper parts. Runs in customer plants confirmed our own results. Here is what one user wrote:

This material seems to machine much better than our previous hard copper bar; it cuts off smoothly, takes a very nice thread, and does not clog the die.

That company makes electrical parts that must be held to close tolerances, and must also have good electrical conductivity. Another company, making switch parts, reports:

Increased feed from 1½" to 6" per minute and do five at one time instead of two.

And a manufacturer turning out disconnect studs says:

Spindle speed increased from 924 to 1161 RPM and feed from .0065" to .0105" per spindle revolution. This resulted in a decrease in the time required to produce the part from .0063 hours to .0036 hours. Material was capable of faster machine speeds but machine was turning over at its maximum. Chips cleared freely, operator did not have to remove by hand.

You can see that this new free-cutting copper is a real contribution to the problem of keeping costs and prices down in certain products having machined copper parts. But that is not the only important thing to me about it. There was also the factor of proof, definite proof that the new material would fulfill the promises made for it, that it actually was not only new but definitely better.

Trial runs, comparative tests, proofs — from such things are correct decisions derived. It seems to me that today we all need not only a receptive mind, but also a demanding one. Every manufacturer owes it as a duty to himself and to the whole country to learn about new materials, and put them to the test. There are many new types of glass, for example, and of plastics, chemicals, drugs—the list is long. Many of these will do new jobs, or perform old ones better. And, of course, some may be no better than older materials. The important thing is to learn now what is new in your industry, demand proofs, put the promising things to the test, and adopt as quickly as possible those advances that prove they can lower costs, improve your product, increase its marketability. Only thus can we in American industry avoid the risk of being either too quick or too slow in making a decision.

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President

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INSTITUTE GAZETTE

(*Concluded from page 350*)

automatically drawn at night when the sun is unable to provide solar energy for heating purposes.

This system is in contrast with the usual solar house which consists simply of a house with a large amount of glass in the south wall through which the sunshine heats the interior but in which no particular attempt is made to collect and store the excess energy of the sunlight, and to use it at night or when the sky is overcast. Other systems generally involve collectors placed in the roof and require some means of circulating the heat from that point to the rest of the building. In an effort to achieve maximum efficiency at minimum cost, the heat collectors in the M.I.T. experiment will be placed immediately behind glass walls on the side of the building most exposed to sunlight.

While it is perfectly feasible to arrange for solar heating of houses, the paramount question is whether such a system can be made as economical as conventional heating systems. In this combination system research is directed toward finding the least costly combination of heat collector and storage unit. It is expected that the research program being conducted will determine whether the solar energy system should be designed for fairly long storage of heat and complete freedom from use of conventional heating systems, or whether the most economic system should provide for no more than overnight heat storage, with an auxiliary heating system for sunless days. The location of the house will, of course, have enormous influence on this feature of the design. It is hoped that the experiments will permit appraisal of the idea for application in any solar climate.

This project is part of the program of research into means of utilizing solar energy undertaken as a consequence of a gift in 1938 from Godfrey L. Cabot, '81. The income from that gift is to be used to study methods of improving our use of solar energy. Among the first projects launched under this program was a house, built in 1939, to study the characteristics of solar collectors of the flat plate type similar to units in use in Florida and California. In this construction, water which was heated in flat plate collectors built into the roof was stored in a large tank in the basement and circulated as needed through radiators. The house was heated entirely by solar energy.* Further work on the house and on other solar energy projects was interrupted by World War II.

The construction of the present small building witnesses the resumption of research into this phase of utilization of solar energy and is under direction of a Steering Committee consisting of Professors Lawrence B. Anderson, '30, School of Architecture and Planning, Albert G. H. Dietz, '32, Department of Building Engineering and Construction, and Hoyt C. Hottel, '24, Department of Chemical Engineering. Dr. Maria Telkes, Department of Metallurgy, is a consultant on the project, and Paul W. Witherell, '40, Department of Building Engineering and Construction, is carrying on the actual research.

* Results were published in the *Transactions of the American Society of Engineers*, 1941.

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TELEVISION—RETROSPECT AND PROSPECT

(*Concluded from page 336*)

Entertainment is an equally legitimate function. There are times in the lives of all of us when the watching of a good play, motion picture, or sports event will answer our needs better than any lecture demonstration, however instructive.

An account of the probable future role of television would not be complete without some reference to its function in industry. Here its primary application is likely to be the surveillance of processes which, for one reason or another, are not readily accessible to human beings. The obstacle may simply be distance. Thus the gauges and indicators of a series of widely spaced automatic substations could readily be watched by a single operator on a set of television receivers in a central station at a convenient location. In other cases the most favorable point of observation may be physically inaccessible or a place of great danger. There have been several applications of this type in the recent past. The classical example is, perhaps, the observation of the atomic bomb explosions and their effects at Bikini. Here numerous television cameras were set up to make possible the immediate viewing of the evolution of the explosion from a number of exposed locations. This experience points to the increased importance of television equipment for the protection of personnel as the industrial use of atomic power becomes more widespread.

In conclusion, I feel justified in stating that the effort spent in developing television has not only had many of the inherent compensations of any research program persistently carried out, but has released a constructive force in our lives which may play a vital role in years to come. It is my earnest hope that my faith in television may not be disappointed and that you may come to share my conviction.

MAIL RETURNS

(*Concluded from page 322*)

However, this is only the beginning. The indexing must be far more detailed than that of an abstracting journal or we leave the student with an ever increasing mass of material to winnow for no great increase in the amount of wheat. Also, to be really useful, indexing done today must enable one to locate the fact that he does not find out he needs until day after tomorrow. More broadly, an index should help one find a fact of whose existence he is unaware.
Lincoln, Mass.

Extrapolations Questioned

FROM JOHN E. BURCHARD, '23:

I am very glad that Dr. Blake has raised the question of the extrapolation of growth curves which has been the basis on which Dr. Rider and others have gone forward to their conclusions. I have myself steadily questioned these extrapolations and thought I had made that clear in my article. What Dr. Blake has said will be very helpful when it is carried, as carried it will be, to my colleagues in the library world.

I should suppose that punch cards might be a real asset in the resolution of the synonym problem which is not only serious in biology but also, for example, in organic chemistry. Though the use of the card to take care of the synonyms or other classification questions in addition to separation of knowledge would inevitably reduce the number of combinations possible in the separation, it might be well to pay such a price on one condition — can the biologists or the organic chemists or others who have these nomenclature difficulties undertake to correlate their synonyms.
Cambridge 39, Mass.

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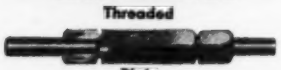

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A STUDY OF MAN EMBRACING ERROR

(*Continued from page 347*)

manner, and then photographed it. The head was then dissected by students, and when the skull became available Dr. Krogman turned it over to a sculptress, Miss Mary Jane McCue, together with the data relating to age, sex, and race, a table of average tissue thicknesses based on the heads of 20 male Oceanic Negroes, and a table of average cephalo facial sizes and proportions in American Negro males. Miss McCue, who had received training in anatomy and physical anthropology, then proceeded to sculpt the tissues over the skull.[16] The resulting restoration was, according to Dr. Krogman, "recognizable as that of the subject chosen." Miss McCue said: "At first glance, in comparing the photos of the head and of the bust, one would hesitate to say that they resembled one another." That seems to be the general verdict of those who see the photographs.

On the whole, the measurements between the head and the bust were very close. This one would expect, for certainly there is some resemblance between the deceased subject and his post-mortem bust. There are differences which we need not consider here. In the Negro there are such more or less constant features, such as kinky hair, thickish lips, broad nose, and small ears, upon which to rely. I think it would be possible to make some recognizable reconstructions on some skulls from Negro cadavers, but not on most. I am convinced that recognizable reconstructions would be impossible in the vast majority of whites. Certainly one could not expect that a close likeness to a person's appearance during life could be established from the skull alone.

The face of the cadaver provides an expressionless appearance to which many other cadavers may bear a fair resemblance, an appearance, by the way, which may very little resemble what the person actually looked like during life. Hence the difficulties which close relatives have often experienced in identifying a body after the lapse of a little time.

Dangers of Overenthusiasm

Omitting size and expression of the eyes, the expression of the face is perhaps something that may never be achieved, and possibly is even unnecessary for the purposes of identification. In whites, the form and color of hair, size and form of lips, shape of nose, eyebrows, and hairline, distribution of subcutaneous fat, and a good many other soft-tissue characters, vary considerably. These bear little or no relation to the skull beneath, and it is precisely these features that give the person his unique appearance. How then can these features be reconstructed in a single person? Accurate reconstructions are not impossible, but, considering the kind of variables involved, they are highly improbable. Further experiments of the kind conducted by Dr. Krogman will finally settle this question.

While the prejudices of an earlier day were directed toward keeping man young, those of our own time are

(*Continued on page 358*)

[16] Miss McCue has described in some detail the methods she followed. See the *FBI Law Enforcement Bulletin* referred to above.

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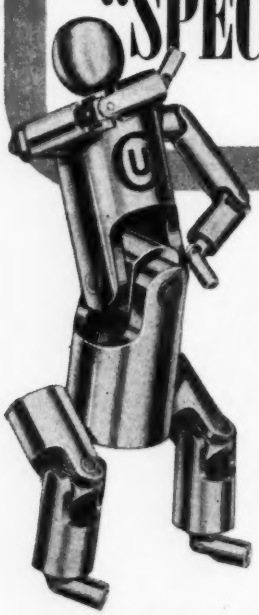

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A STUDY OF MAN EMBRACING ERROR

(*Continued from page 356*)

pitched in an opposite direction — toward making him as old as possible. Every discoverer of a skull hopes that his find will prove to be that of a prehistoric man. It is a worthy hope to entertain, and it is being more often realized than many of us ever expected would be possible. It is a hope to encourage, but it is one which must be held with caution. The surface of the earth has barely been scratched for the remains of prehistoric man. Let it be scratched often, hopefully, and with enthusiasm, but not with too much enthusiasm.

As illustrative of the dangers of overenthusiasm in prehistoric research — overenthusiasm which has led even the most distinguished authorities astray — are the interpretations which have been given to the Talgai and the Cohuna skulls, both from Australia.

The Talgai skull, much crushed and distorted, was found on the Darling Downs, Queensland, in 1884, but was not described until 1918. In that year Dr. S. A. Smith described it[17] as a very primitive ancestral representative of the Australian race. What impressed Dr. Smith most was the apparently enormous size of the palate. Indeed, it was chiefly upon this feature that its claim to antiquity was based. Most authorities agreed. But recently Dr. Milo Hellman,[18] the distinguished student of the human dentition, has made an ingenious reconstruction of the palate which proves beyond doubt that the palate was not larger than that of the average Australian aboriginal of today. Hence, the claim to antiquity on morphological grounds for the Talgai skull can no longer be maintained.

Mistaken Identity

The Cohuna skull was found in 1925 at Cohuna, on the Murray River, Victoria, and is now circulating in "the literature," through no fault of its own, as another early ancestor of the Australian aborigines. The manner in which this skull crept into print should be a lesson to the unwary. When discovered, the skull was heavily coated with mineral incrustations. Some of this covering was removed, but not all. Sir Colin Mackenzie, Director of the Australian Institute of Anatomy, mistook the adhering mineral incrustation for bone. He made a tracing along the middle line of the skull, and this, together with some measurements, he sent to Sir Arthur Keith in London. With nothing more than this to go on, Sir Arthur expressed the opinion[19] that: "Taking it all and all, the Cohuna skull — with the exception of the Java and Peking specimens, and perhaps of Piltdown — represents the most primitive form known to us."

Alas, when the incrustations were removed, the Cohuna skull stood revealed in all its pristine beauty as one all of whose characters fall well within the range of those of the modern Australian aboriginal!

(*Continued on page 360*)

[17] S. A. Smith, "The Fossil Human Skull Found at Talgai, Queensland," *Philosophical Transactions of the Royal Society*, London, 208: 351–389 (1918).

[18] Milo Hellman, "The Form of the Talgai Palate," *American Journal of Physical Anthropology*, 19:1–17 (1934).

[19] Sir Arthur Keith, *New Discoveries Relating to the Antiquity of Man*, London and New York, 1931, pages 304–310.

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A STUDY OF MAN EMBRACING ERROR

(*Continued from page 358*)

During the first decade of this century, the description of the fossil ancestors of man was undertaken on a mass-production basis by Professor Fiorino Ameghino of Buenos Aires, Argentina.[20] In the course of a few years Professor Ameghino described more than a dozen alleged representatives of Tertiary and Quaternary man in South America, including such grandiosely named forms as *Homo caputinclinatus, Homo sinemento, Homo pampaeus, Diprothomo platensis,* and *Tetraprothomo argentinus.*

A Cat Grins

Professor Ameghino claimed great antiquity for these five groups of prehistoric man, describing *Homo pampaeus,* in particular, as "the most ancient representative of the genus *Homo* . . . of which we now possess the skull."

The Professor's reports were epoch-making, if true. Representatives of the American Bureau of Ethnology were therefore sent to South America to examine the skeletal remains and sites from which they had been recovered. In every case the verdict was the same: The skulls were those of American Indians of the recent period and had absolutely no claim to antiquity of any kind.

Tetraprothomo was represented by a single vertebra (the atlas), and a thigh bone (the femur). The first proved to be that of a relatively modern Indian, and the second, the thigh bone of a fossil cat! Nothing but the grin on the face of the long-vanished Argentine cat remained of Professor Ameghino's claim that its thigh bone once graced the muscular lower extremity of an ancient precursor of man.

A Tale of Tailless Apes

Among Professor Ameghino's massive failures must be numbered his attempts to endow South America with the fossil remains of anthropoid apes. The skull of a platyrrhine monkey, *Homunculus patagonicus,* is as near as Ameghino ever got to an anthropoid ape, which is a very long distance indeed. But the attempt to find anthropoid apes in South America dies hard. As recently as 1929, the alleged discovery of living anthropoid apes on that continent received world-wide publicity.

It appears that in 1917 while travelling in the Motilones districts of Venezuela and Colombia, Dr. Francis de Loys,[21] a French geologist, and his party were suddenly attacked by two great tailless apes. The female was shot dead, the male was wounded but escaped. The body of the dead animal was said to weigh 115 pounds and to have a height of five feet, two inches. The jaws contained 32 teeth, the number typical for the Old World Primates. The discovery of this new ape was first given to the world

(*Concluded on page 362*)

[20] Fiorino Ameghino, *Contribucion al conocimiento de los mamiferos fosiles,* 1889. A full account and examination of Ameghino's claims will be found in Aleš Hrdlička, "The Skeletal Remains of Early Man in South America," *Early Man in South America,* Bulletin of the Bureau of American Ethnology, No. 52, Washington, 1912, pages 153–395.

[21] Francis de Loys, "A Gap Filled in the Pedigree of Man?" *Illustrated London News,* June 15, 1929.

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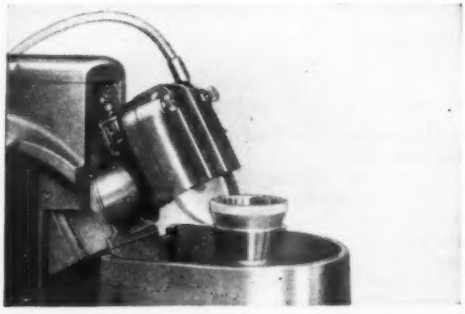

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A STUDY OF MAN EMBRACING ERROR

(*Concluded from page 360*)

on March 11, 1929, by Dr. George Montandon [22] of the Muséum d'Histoire Naturelle of Paris. Dr. Montandon was fully convinced that the evidence rendered it indisputably certain that living anthropoid apes were to be found in South America.

No fossil remains of anything resembling an ape had ever been found anywhere in America, and a large body of evidence of various kinds made it virtually certain that none ever would, for the simple reason that no anthropoid apes ever existed in the New World. Hence, the announcement of living apes in South America created something of a sensation. Dr. de Loys had had the good judgment to make a photograph of his ape immediately after it had been shot. The hardships suffered by Dr. de Loys' party unfortunately prevented the preservation of the bones of the specimen. The skull was reported to have been "dissolved" by the salt which the expedition's cook had kept in it! But although that story had to be taken with a very considerable grain of that substance, the giant Primate with 32 teeth, no tail, a great height and weight, strongly suggested an anthropoid ape. The published photograph of this ape,[23] seated on a box, showed an animal with stubs where its thumbs should have been, a nose with nostrils separated by a wide septum and flaring and deflected in an outward and upward direction. All these are traits of a monkey belonging to the genus Ateles, or spider monkeys. Furthermore, the spider monkeys inhabit the region in which Dr. de Loys' ape was shot. What had happened to the other four teeth it should have possessed is uncertain; perhaps they were impacted or even unerupted. As for its missing tail, perhaps it had been salted down or bitten off in a fight. Who can say?

Possibly Dr. Montandon's own strange views embraced in the theory which he called "ologenism," namely, the view that the anthropoid apes and man had originated independently at different times over the whole of the earth, had something to do with his vigorous championing of this monkey's claim to anthropoid status.

Perhaps some of the facts recounted in this article will serve to convince the reader that there can be no place for prejudice in science. Prejudices are wasteful of effort, confusing of thought, and retardative of progress. The scientific mind is the critically open mind, and even if, occasionally, it falls into error, let us remember Bacon's statement: "Truth grows more easily out of error than out of confusion."

[22] George Montandon, "Un Singe Actuel en Amérique," *Revue Scientifique*, March 11, 1929.

George Montandon, "Un singe d'apparence enthropoide en Amérique du Sud," *Comptes Rendus des Seances de l'Academie des Sciences*, Paris, March 11, 1929, pages 815–817.

George Montandon, "Découverte d'un Singe d'apparenceanthropoide en Amerique du Sud," *L'Anthropologie*, 39:137–141 (1929).

George Montandon, "Un Singe Anthropoide Actuel en Amérique," *Revue Scientifique*, Paris, May 11, 1929, pages 268–269.

[23] For a critical examination of Montandon's and de Loys' claims see M. F. Ashley Montagu, "The Discovery of a New Anthropoid in South America?" *The Scientific Monthly*, 29:275–279 (1929).

THE TECHNOLOGY LOAN FUND BOARD

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Current principal repayments during the year exceeded new loans made over *fourfold*, and by December 31, 1946, 1,922 men — nearly *three-quarters* of the 2,647 receiving loans since the Fund was established in 1930 — had completely discharged their financial indebtedness to it. Many of the 1,922, and others as well, had taken advantage of the provision that "payments may be anticipated," for $42,667.90 of notes were paid off during 1946 *in advance of maturity*.

The data given below summarize the Fund's transactions during 1946 together with cumulative figures for the past sixteen years.

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Cambridge
March 1, 1947

Cumulative Record of the Technology Loan Fund from its establishment in 1930 up to December 31, 1946, and the corresponding figures up to December 31, 1945, together with net changes during 1946.

	At Dec. 31 1946	*At Dec. 31 1945*	*Net Changes during 1946*
Items of Outgo			
Number of men receiving loans	2647	2608	+39
Total amount loaned	$1,918,740.75	$1,895,273.75	+$23,467.00
Average per capita loan	$724.91	$726.71	−$1.80
Items of Income			
Number of men whose indebtedness has been completely discharged	1922	1762	+160
Principal repayments *in advance*	$540,875.27	$498,207.37	+$42,667.90
Other principal repayments	$979,983.79	$924,662.50	+$55,321.29
Total principal repayments	$1,520,859.06	$1,422,869.87	+$97,989.19
Total principal matured, considering "advance repayments" as matured when paid	$1,556,277.56	$1,460,825.98	+$95,451.58
Collection Ratio, *i.e.* percentage of total maturities paid	**97.8%**	**97.4%**	**+0.4%**
Matured principal in arrears	$29,792.19	$32,762.12	−$2,969.93
Actual "written off" accounts	$5,626.31	$5,193.99	+$432.32
Total maturities unpaid	$35,418.50	$37,956.11	−$2,537.61
Interest received	$208,239.87	$199,235.84	+$9,004.03
Notes Outstanding	$392,255.38	$470,006.53	−$77,751.15

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HUMAN RELATIONS IN INDUSTRIAL CIVILIZATION

(*Concluded from page 344*)

has produced a new culture. At the same time, it has failed to achieve an organic synthesis. By scattering its appeals, it has failed to give them depth in time and experience. Like the machine on which it depends, its life organization is impersonal, detached, specialized.

Reversal of Trend?

Whether or not it is possible to reverse the trends in community life, which industrial metropolitanism has set in motion, is difficult to say. To be sure, straws in the wind are blowing in another direction, for a flight from the industrial city seems to have begun and to have made fair progress in the last quarter of a century. It appears to be still too early to discover clearly what the next step will be.

Accelerated by such examples of decentralized power as the gasoline engine and the electric transmission lines, industries and individuals are beginning to find places more favorable for growth in the smaller communities of the metropolitan fringe. A reversal of the centripetal city of industrialism appears in the broad, regional views of city plan commissions. A new architecture, the values of which are natural, seems a part of this orientation. The literature of a Frank Lloyd Wright or a Ralph Borsodi is a beautiful and stirring plea for a revolt against industrial metropolitanism. A hard-headed economic realism which recognizes and is beginning to respect the physical and economic limits of metropolitan concentration is perhaps as convincing an indication of a new way of thinking about the modern community as any. Certainly the burden of human pathologies — crime, mental disease, vice, poverty, family disorganization — which industrial urbanism is piling on the shoulders of metropolitan bureaucracy is another indication pointing to the need for change. Educators would add to this testimony their earnest conviction that a more favorable environment for human growth and for satisfactory and wholesome group living must be found.

In brief, there is a sense, no longer weak and tentative but tragic, that the whole texture of modern man's means and meanings is in considerable jeopardy so long as the industrial city in the form and spirit of the past is maintained as the matrix of his multitudinous and differentiated relationships.

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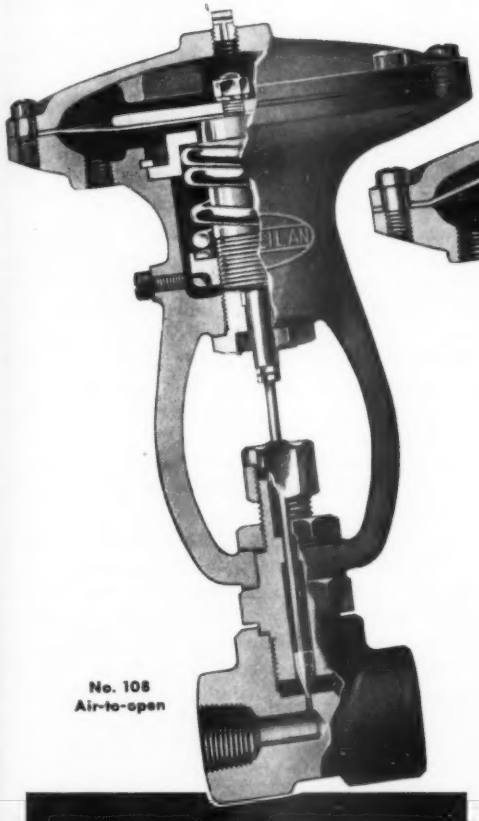

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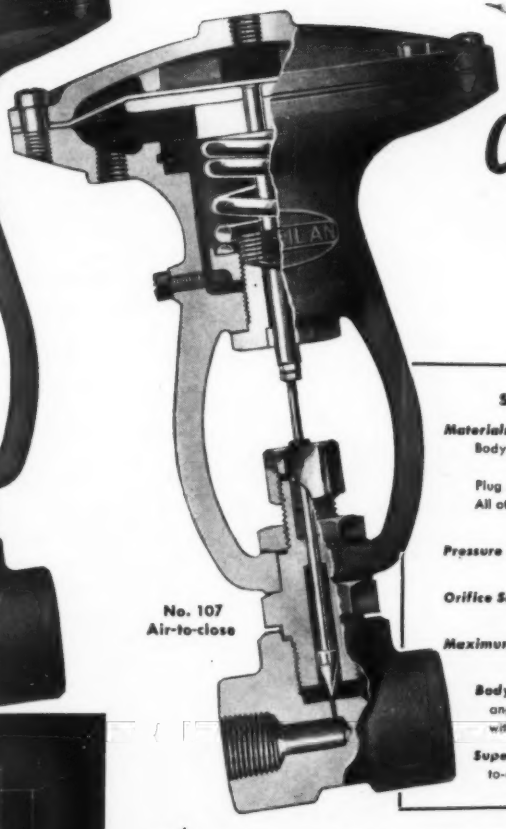

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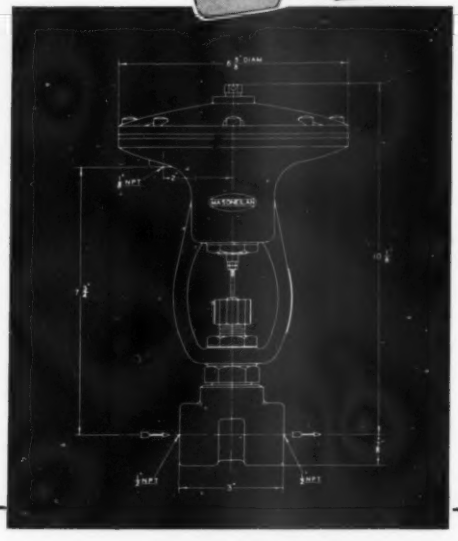

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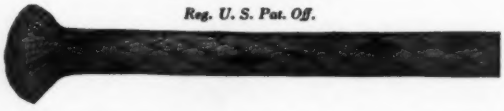

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STEPPING STONES TO VICTORY

(*Continued from page 340*)

galleys. You'll have to hold off starting work on the receiving barracks, though, until you've finished enough of the hospital Quonsets to accommodate 200 patients."

"Where'll we put transients in the meantime?" objected Herd, "we'll no sooner be ashore at Hollandia than the department will start sending drafts of men there to join ships, and when the men get to Hollandia, God knows where the ships will have gone! Where will those men sleep? In the mud? Where will they eat?"

"They'll have to be billeted on the Seabees," answered Shanley. "You'll have to set up some extra tents at each battalion camp for transients and feed them in the battalion mess halls."

"Oh, yes! The battalions will have to take care of them," assented Wright, "but let's hope transients don't pile up the way they have at Milne Bay. We've had over 10,000 in barracks there and I believe someone on the staff," and he looked hard at Dingwell, "once estimated that a 1,000-man barracks was big enough for Milne. No, I'm not trying to rub that one in, Captain. How many battalions do you think we'll need at Hollandia? My first offhand guess is six."

"Six battalions! You're way off! Mike, here, has been talking about three, but I think two could do the job," was Dingwell's reply.

"Two's not enough, not near enough!" objected Herd, "the work we'll have to do for the Army will take two battalions and it's not mentioned on your list! Who's to build the air strips? Who builds the 25 or 30 miles of road leading to the strips? Who builds the road leading to General MacArthur's and Seventh Fleet headquarters in those 'hills' (mountains I'd call them if I can read a map) overlooking the lake?"

"Cool off! Cool off!" admonished Dingwell, "the Army's going to build the strips and the roads. We'll only have to build the roads through areas assigned to us."

"I'll believe it when I see it," countered Wright, "the 55th Seabees built the strip at Merauke. The 60th built not only the strip and 35 miles of road at Woodlark but the toughest end of the Finschhafen strip. And now the 40th and 78th are helping Army engineers with the Manus strips instead of starting work on the Fleet base."

"We know all about that," was Dingwell's reply, "and the Admiral knows all about it, too, and approves of it. We've got to concentrate our forces on the most important thing in the early phases of a job, and in many cases the most important thing is to help the Army get the air strips and roads working. But don't get the idea that the Seabees did all the roads and the airstrip work in the Southwest Pacific! Ever see Moresby, Dobodura and Nadzab? The Army is going to build a big base at Hollandia, far bigger than ours, and they're going to put in enough engineers to do the job! All I want to know is how many Seabees you'll need to put in these units!" and he tapped the list.

"O.K." agreed Wright, "we'll give you an estimate in a couple of days but in the meantime I'd suggest we think in terms of four battalions: one to be divided between the headquarters job and the Tanamehra tank farm; two

(*Continued on page 368*)

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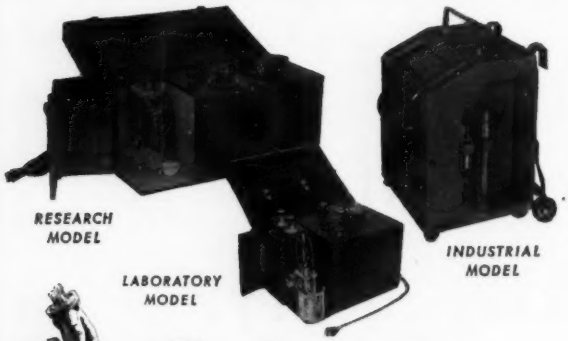

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STEPPING STONES TO VICTORY

(*Continued from page 366*)

for the supply depot and hospital; and the fourth for the ship repair unit and miscellaneous jobs. Suppose we set up Tate's 24th Regiment for the job which includes the 102d, 113th, 119th, and 122d Seabees — four battalions of 1,100 men each?"

"Looks like too many men to me," grumbled Dingwell, "but what do you say, Mike? Shall we agree to that as a tentative setup until they've completed a real estimate of what's needed?"

"By all means," answered Shanley, "let's plan on enough men this time and not have another Milne Bay where three companies struggled for months with a job to which we'd have assigned six battalions if we had had them. Milne only started to get out of the mud when Hewett's 91st Seabees got there in November and nothing at Milne has been finished when it was needed. I'm all for an adequate force at Hollandia. We'll need some Special Seabees there to do the stevedoring, too. What outfit do you suggest?"

"Half the 19th Special from Finschhafen."

"Fine, make it half the 19th," agreed Dingwell. "Of course, all this is tentative and strictly hush-hush. As soon as you have roughed out a real estimate of the men, equipment, and materials needed at Hollandia, bring it over to my office. We'll discuss it with Captain Crawford and the admiral will send a formal directive to the commander of the Service Forces after we've got approval from general headquarters."

The formal directive for the construction of a new base usually took the form of a "secret" or "top secret" letter stating the location of the base, listing its principal components and giving the date upon which each would have to be substantially finished and ready for service. The sources of the major items of material and equipment required for the construction of the base under consideration, and the identity of the Construction Battalion units to be assigned to the project, would also be specified. The receipt of the directive by the Service Force would be followed by conferences at which innumerable details were settled.

Perhaps the most important of these were the allocation of Seabee units to urgent projects of interest to both the Army and Navy during the assault and early phases of an operation, and the location of sites.

The location of sites was always a difficult problem as topographic and hydrographic information on an area still in the hands of the Japanese was usually meager and often unreliable. Using the best available maps, which were generally the product of aerial photographic reconnaissance, the land, air, and naval forces would prepare preliminary plans showing proposed locations of the units they intended to install at a new base and the area required for each.

These plans would be submitted to General MacArthur's chief engineer, Major General Casey, at a conference at which all three Forces presented their reasons for requesting the sites they had selected. It usually developed that all three Forces felt they had the best of reasons for requesting all the really good sites, but compromises would finally be made and a tentative

(*Continued on page 370*)

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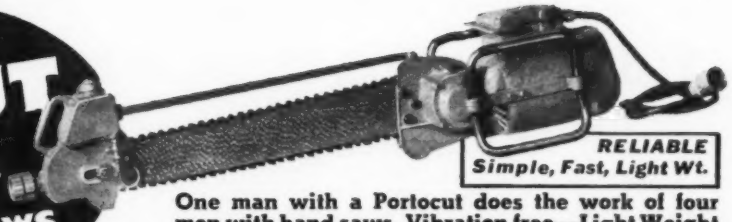

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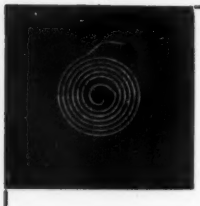

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STEPPING STONES TO VICTORY

(*Continued from page 368*)

allocation of sites would be approved by general headquarters.

In the meantime, orders would have been placed with the Navy Department by the commander of the Seventh Fleet for such necessary major units as additional construction battalions or large functional components — ship repair units, hospitals, supply depots, or large radio stations — as might have to be brought out to the Southwest Pacific from the United States for the proposed base. The Construction Forces, through the commander of the Service Forces, would similarly order miscellaneous building materials, such as lumber, piping, plumbing supplies, wiring, and so on. Shipping for these units and materials had to be arranged with the chief regulating officer at general headquarters, and it was not always easy to convince that much harassed member of General MacArthur's staff of the wisdom of allocating to the Construction Forces of the Seventh Fleet a sufficient proportion of the limited tonnage available to the Southwest Pacific Command.

Transportation would next be arranged for the Seabees that were to accompany the assault forces. LST's would be used, if available, for carrying forward the advance echelon of Seabees moving to a new job, but shortage of LST's frequently made it necessary to move construction battalions in Liberty ships. This enormously complicated the problem of getting ashore. Unloading a Liberty ship by means of lighters assembled from NL pontoons is a back-breaking and tedious process, especially when much of the cargo consists of heavy pieces of construction equipment which tax the capacity of the ship's cargo booms.

The first days ashore at a new base were always tough ones. At the best, there were days of unbelievably hard work in unbelievably deep mud with unbelievable swarms of mosquitoes standing by to see that the weary got no sleep. At the worst, the first days ashore could be almost beyond endurance. Conditions of the latter kind were described by Commander J. C. Tate, Officer-in-Charge of the 24th Naval Construction Regiment, in the following words quoted from his report on the first few days he spent ashore at Hollandia with a reconnaissance party.

"The beach," Commander Tate reported, "was a narrow strip of white sand with a mangrove swamp behind it. The Japanese had abandoned great stacks of supplies, ammunition, and fuel on the beach as our forces stormed ashore. The cargoes of 11 LST's, all heavily loaded with supplies and equipment for Army units, were stacked on the beach. The Army was building roads back from the beach, but combat activities slowed the work and but little progress had been made by the end of the second day. That night a single Jap bomber swooped in, dropped his bombs on the fuel and ammunition, and then made a strafing run on the beach. The loss from those bombs was heavy. The fire raged for several days with bombs and ammunition going off intermittently. Men were being killed and injured all around. Large pieces of red-hot bomb fragments landed within arm's length of us, but luckily none of our party was injured."

(*Continued on page 372*)

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IS STILL A CRAFT

STEPPING STONES TO VICTORY

(*Continued from page 370*)

Although it was not unusual for Seabees to have to deal with snipers during the early phases of a new construction job, only one battalion in the Southwest Pacific had to put down the shovel and pick up the gun as a unit. This was the 40th Battalion, the men of which acquitted themselves so commendably as infantrymen during their first days at Manus that the 40th was given a Presidential Citation recommended by General MacArthur.

During their first days ashore, in an area that was being taken from the enemy, the Seabees would devote their energies to the construction of roads, piers, air strips, and other work urgently needed by both the Army and Navy. During this phase of their activity, the officer-in-charge of the Seabees reported to the task force engineer who was held responsible by the commander of the entire operation for the effective co-ordination of all construction activities during its assault and combat phases. The task force engineer was usually an officer of the Army Engineers, but in at least one case an officer of the Civil Engineer Corps of the Navy served as a task force engineer. With the termination of the combat phases of the operation, control of the Seabees would revert to the Navy and they would proceed with the construction of naval facilities. This work would be done under the technical direction of the civil engineer officer heading the Seabee organization assigned to the project. The organization might be anything from a detachment with a junior officer in charge, if the job were a small one, to a brigade, or even two or three brigades totaling 15,000–20,000 men headed by a commodore, if the project were the construction of a fleet base. In any event, the senior civil engineer officer who headed the organization reported to the commanding officer of the base under construction and not directly to the commander of the construction forces. Unity of command at each base was thereby maintained, and at the same time, the commander of the Construction Forces, through his position on the staff of the commander of the Service Force, was able to function as the "type commander" of all Seventh Fleet Seabees and retain a fairly satisfactory control of what they were doing throughout the Southwest Pacific area. Occasionally, friction developed between the officer-in-charge of the Seabees at a new base and its commanding officer, especially if the former were a bit obtuse in adjusting himself to naval and military customs and if the latter proved to be an "amateur engineer." In no case, however, was such friction permitted to delay seriously the completion of a project.

The actual construction of one of the larger bases very naturally involved many types of engineering. At a fleet base such as Manus, there would first be work for experienced surveyors, topographers, and hydrographers who furnished the data used in laying out the entire base and effecting necessary changes and adjustments in the tentative site allocations made before our forces landed. Then there was work for designers in many engineering specialties. Highway engineers were needed to plan the air strips and the road system which might well comprise more than 100 miles of macadam pavement. Sanitary engineers designed the water supply, purification, and

(*Concluded on page 374*)

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STEPPING STONES TO VICTORY

(*Concluded from page 372*)

distribution systems which, at Manus, were capable of delivering in excess of 4,000,000 gallons of filtered water per day to the base and to ships lying there. In the construction of the rapid filters at this base, which were designed by Lieutenant Commander L. G. Phillips of the 5th Regiment, wood-stave tanks were utilized for filter chambers while bolted steel oil tanks formed the raw and clear water reservoirs. Chemical feeding and mixing devices and control valves were improvised from available odds and ends with the assistance of the well-equipped machine shops of the ship repair unit. The filter plants at Manus, and two similar but smaller ones built at Milne Bay from designs by Commander Earl Kelly of the 12th Naval Construction Regiment, did much to safeguard the health of personnel and minimize unnecessary loads on the hospitals of the bases. Architects, and engineers with architectural experience, were, of course, needed to plan the hospitals, groups of office buildings, shop buildings, storehouses, recreational centers, and personnel buildings of a big base. Structural engineers were needed to design and check the many deviations from standard methods of erecting and the use of prefabricated units which material shortages forced the Seabees to adopt.

Finally, experienced construction engineers, mechanics, craftsmen, and laborers were needed to realize the plans of the designers. Men of many types were needed; men who knew not only how to operate, but also how to maintain and repair bulldozers, excavators, cranes, and pile drivers; men who could coax trucks through mud deeper than any truck was ever intended to run in; men who could simultaneously fell trees and deal with Japanese snipers; men who could haul logs to one of the portable saw mills with which construction battalions were equipped; men who could convert the logs into structural timber; men who could build wharves and assemble huge floating dry docks of a new and hitherto untried type; men who could, and would, befriend the residents of a native village by devoting their precious spare time to repairing the organ of the village church; men who could build a huge naval base, such as Manus, in less than six months! The job demanded enlisted men and reserve officers of a character and ability unique in the annals of military engineering. In short — Seabees!

It is difficult to tell any part of the story of the Seabees without making it appear that, to the narrator, they were more than a service organization. Their work was, of course, secondary, and was of importance only insofar as it supported combat units. There can be no doubt, however, that to the fighting forces which brought about the defeat of Japan, the naval bases constructed by the Seabees were, in fact, stepping stones to victory.

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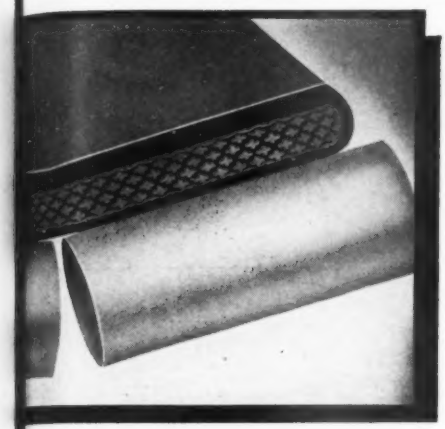

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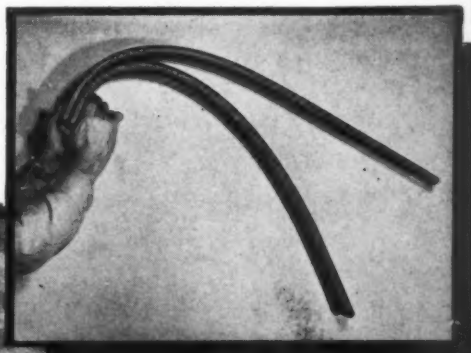

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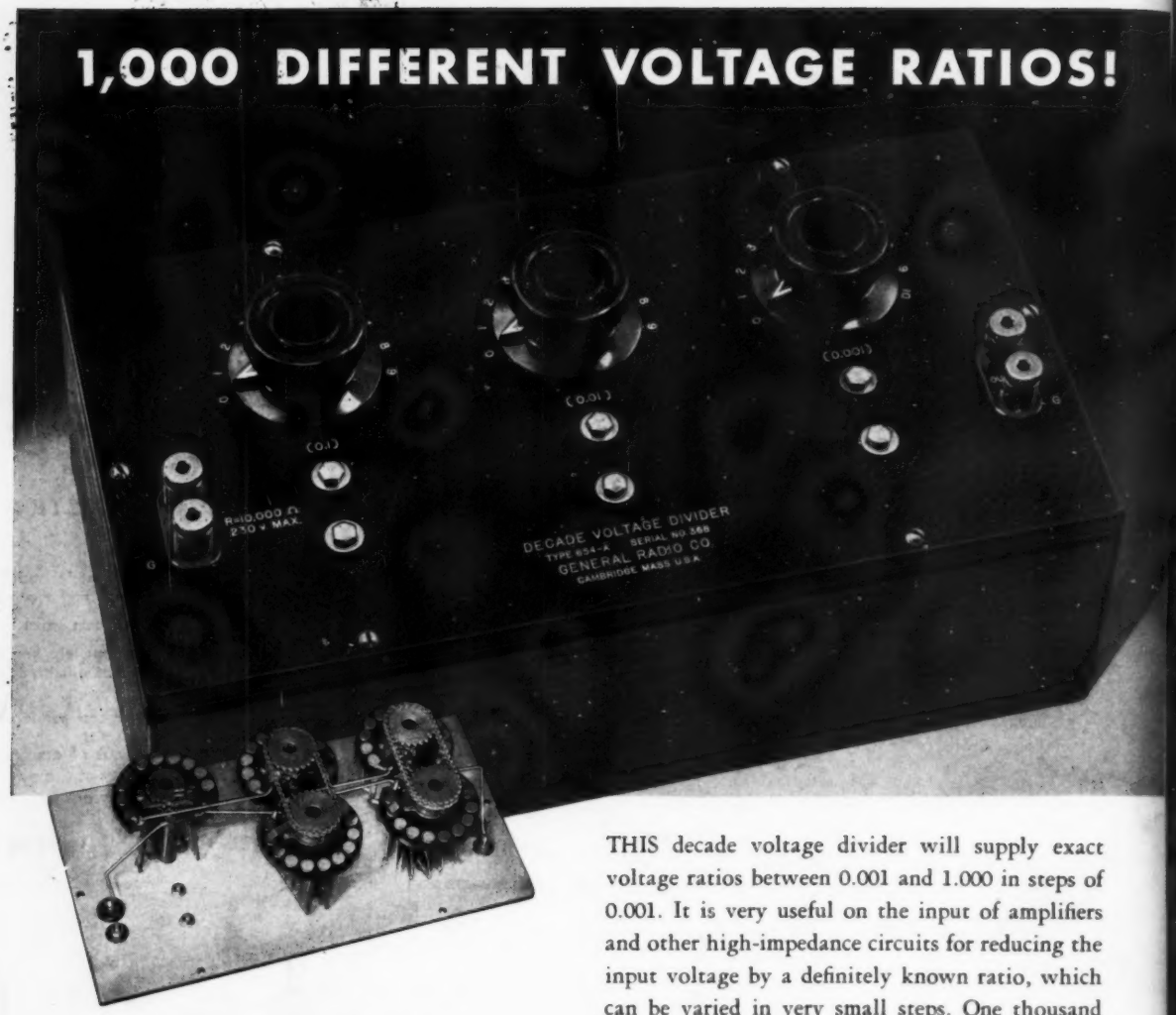

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